

AUG 29, 1986

5.0

## **Geophysical Survey and Site Sampling**

# **Health and Safety Plan**

**for**

**Western Processing Site  
Kent, Washington**

**The Sampling and Test Plan Contracting Group**

**HDR Infrastructure**  
A Centerra Company

In Association with  
**Engineering Enterprises, Inc.**  
**Northern Technical Services, Inc.**  
**Farr, Friedman and Bruya, Inc.**

USEPA SF



1518502

## APPROVALS

## INVOLVED PARTIES

SIGNATURE

DATE \_\_\_\_\_

AFFILIATION: \_\_\_\_\_

SIGNATURE

DATE \_\_\_\_\_

AFFILIATION: \_\_\_\_\_

SIGNATURE

DATE \_\_\_\_\_

AFFILIATION: \_\_\_\_\_

## HDR INFRASTRUCTURE

## PROJECT MANAGER

DATE \_\_\_\_\_

CORP. HEALTH &amp; SAFETY DIR.

DATE \_\_\_\_\_



## **ACKNOWLEDGEMENTS**

I AM FAMILIAR WITH THE HEALTH AND SAFETY PLAN PERTAINING TO THE WESTERN PROCESSING SITE. I UNDERSTAND THE CONTENTS OF THE HEALTH AND SAFETY PLAN AND ANY QUESTIONS I HAD REGARDING THE PLAN HAVE BEEN SATISFACTORILY ANSWERED.

**NAME**

**COMPANY**

DATE[illegible]

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## 1.0 GENERAL INFORMATION

### 1.1 Health and Safety Plan Identification

Site Name: Western Processing, Inc.  
Address: 7215 South 196th Street  
Kent, Washington

Date Prepared: August 29, 1986

Prepared by: Julie Novacek, ph 402-399-1041

Reviewed by: M. Ramanathan, PhD, ph 215-687-2300

T. Coats, IH, ph 402-399-1284

Project Manager: Kenneth Lepic, P.E., ph 206-682-9000

Address: 1100 East Lake Avenue, E  
Seattle, WA 98109-4408

Corporate Health & Safety Officer: Tracy Coats,  
ph 402-399-1284

### 1.2 Adherence to the Health and Safety Plan

All persons on-site must be familiar with the instructions and information contained in this Health and Safety Plan. All persons on-site must read this plan and sign a statement to the effect that they have read and understood this plan. THE INFORMATION CONTAINED IN THIS HEALTH AND SAFETY PLAN WILL BE ADHERED TO AT ALL TIMES. Any modifications made will be presented to the on-site team during a safety briefing and documented on forms found in Appendix B to this document.

### 1.3 Involved Parties

#### 1.3.1 Site Contractor

HDR Infrastructure  
A Centerra Company

Home Office:  
8404 Indian Hills Drive  
Omaha, NE 68114-4049  
800-228-9680

Local Office:  
1100 East Lake Avenue, E.  
Seattle, WA 98109-4408  
206-682-9000  
Contact: Kenneth Lepic

### 1.3.2 Subcontractors

Engineering Enterprises, Inc. (EEI)  
21818 S. Wilmington Ave., Suite 405  
Long Beach, California 90810  
213-518-4597  
Contact: Stephen Testa

Northern Technical Services, Inc. (NORTEC)  
14715 N.E. 95th Street  
Redmond, Washington 98052  
206-881-7700  
Contact: Dick Sylwester

Farr, Friedman & Bruya, Inc. (FFB)  
211 NW 52nd Street  
Seattle, Washington 98107  
206-784-0660  
Contact: Jim Bruya

Hokkaido Drilling & Developing Corp. (Hokkaido)  
10416 244th Street East  
Graham, Washington 98338  
206-847-3579  
Contact: Bill Dodge

ST Engineering, Inc. (ST)  
733 7th Ave., Suite 210  
Kirkland, Washington 98033  
206-822-6036  
Contact: Dwight Holobaugh

Environmental Toxicology International, Inc. (ETI)  
600 First Avenue, Suite 532  
Seattle, Washington 98104  
206-622-9040  
Contact: Kathryn Kelly

O.H. Materials Co. (OHM)  
3900 Industrial Blvd.  
P.O. Box 279  
W. Sacramento, CA 95691-3441  
800-537-9540 (24 hr.)  
Contact: James Higgins

### 1.4 Site Background

The Western Processing, Inc. facility operated as an industrial waste processing and recycling facility from 1961 to 1983. Initially, the facility processed animal byproducts and brewer's yeast but later expanded its operations to include the handling, processing, and recycling of a wide variety of industrial waste products, including solvents, flue dust, battery chips, acids, and cyanide solutions.

## 1.5 Scope of Services

The services to be conducted at the Western Processing site are briefly summarized below. A detailed discussion of the scope of services can be found in Section 3.0 of the Study Plan (Field Operations Plan).

- Conduct geophysical survey.
- Collect surface soil samples.
- Drill soil borings and collect soil samples.
- Excavate exploration sites and collect soil samples.
- Locate, expose, and sample buried utilities, tanks, and drums.

## 2.0 SAFE WORKING PRACTICES

### 2.1 Authorized Field Team Members

All authorized field team members will read and be familiar with the contents of this Health and Safety Plan, and will attend an initial health and safety briefing pertaining to the plan by the health and safety officer. Authorized field team personnel will include the project manager, assistant project manager, on-site coordinator (OSC), site safety officer, documentation officer, samplers, monitoring personnel, geologists, heavy equipment operators, field technicians, and various subcontractors. One team member may fulfill several duties.

The proposed list of team members and their role in the Western Processing project follows. We reserve the right to substitute other qualified personnel when necessary.

| <u>Role</u>              | <u>Name</u>       | <u>Company</u> |
|--------------------------|-------------------|----------------|
| Project Manager          | Kenneth Lepic     | HDR            |
| Assistant Proj. Mgr.     | Peter McCormick   | HDR            |
| On-Site Coordinator      | Ken Scheffler     | HDR            |
| Health & Safety Officer  | Julie Novacek     | HDR            |
| Air Monitoring Personnel | Kevin Denny       | HDR            |
|                          | Tracy Coats       | HDR            |
| Field Samplers           | Dick Sprague      | HDR            |
|                          | Al Erickson       | HDR            |
|                          | Rand Miller       | HDR            |
| QA/QC Officers           | Peter McCormick   | HDR            |
|                          | Dr. M. Ramanathan | HDR            |
|                          | Jim Farr          | FFB            |



|   |                |     |
|---|----------------|-----|
| Documentation Officer                     | Mike Reynolds  | HDR |
| On-Site Technicians<br>(Runners & Decon.) | To be Assigned | HDR |
| Air Monitoring Technician                 | David Actor    | ETI |
| Drillers                                  | To be Assigned | EEI |
| Geologist                                 | To be Assigned | EEI |
| Excavation Equipment<br>Operators         | To be Assigned | EEI |
| Buried Container Samplers                 | To be Assigned | OHM |
| Buried Container Equipment<br>Operators   | To be Assigned | OHM |

## 2.2 Site Visitors

All visits must be prearranged with the on-site coordinator, and visitors must sign in and out at the main gate. All visitors must read and sign this Health and Safety Plan, and write their purpose for observing. The health and safety officer will inform visitors of hazards, and will provide them with site-specific safety procedures before they will be allowed in the exclusion zone.

No visitor will be allowed in the exclusion zone unless they have been fully equipped in the appropriate personal protective equipment (minimum Level D modified). No visitors will be allowed in the exclusion zone if the required personal protective equipment has been upgraded to Level B, unless they have had previous certified training for Level B protection.

Visitors will only be allowed to observe operations, and must obey all instructions of the health and safety officer. No visitors will be allowed within a 30-foot radius of intrusive activities (surface sampling, drilling, excavation, drum/tank/utility sampling).

## 2.3 Personal Restrictions

- The required level of personal protective equipment must be worn by all on-site personnel.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in the exclusion zone and the contamination reduction zone.
- Smoking, carrying lighters and/or matches is prohibited in the exclusion zone.

- No contact lenses may be worn on-site.
- No jewelry may be worn on-site, except for watches which will be disposed of if they become contaminated.
- No facial hair which interferes with a satisfactory fit of the mask-to-face seal is allowed on personnel required to wear respirators.
- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. PRESCRIBED DRUGS SHOULD NOT BE TAKEN BY PERSONNEL ON RESPONSE OPERATIONS WHERE THE POTENTIAL FOR ABSORPTION, INHALATION, OR INGESTION OF TOXIC SUBSTANCES EXISTS UNLESS SPECIFICALLY APPROVED BY A QUALIFIED PHYSICIAN. Alcoholic beverage intake will not be allowed during breaks.
- The entire body should be thoroughly washed in the decontamination trailer after completing decontamination procedures.
- NO PERSON WILL ENTER THE EXCLUSION ZONE ALONE.

#### 2.4 Site Safety Precautions

The following site restrictions will be in effect:

- Barricades/ropes will be placed around any known dioxin wastes remaining on-site so that a safe distance can be maintained.
- The bridge crossing Mill Creek from Area V to Area VI will not be used either by foot or on vehicle. An appropriate sign will be placed on the bridge.
- Extreme care will be used when drilling equipment is operated near the overhead high voltage transmission line in Area X and the overhead power lines in Area II.
- Extreme care will be used during any operations involving underground utilities.
- Barricades/ropes will be used to prevent unauthorized entry of personnel and equipment into excavation areas.
- The Interurban Trail will be blocked off while drilling or excavation activities are being conducted in the area.
- The on-site vehicle will maintain a safe distance from excavation areas.

#### 2.5 Prevention of Contamination/Exposure

Ways in which on-site personnel may become contaminated include:



- being splashed by contaminated liquids while sampling or moving drums;
- coming in contact with contaminated drum solids or liquids due to unsteady or corroded drums;
- walking through contaminated materials, either in solid or liquid state;
- being in contact with contaminated equipment;
- being in contact with contaminated solid substances in wastepiles or on the soil surface;
- sitting or kneeling on the ground;

On-site team members will avoid becoming contaminated as much as possible.

On-site personnel will avoid exposure to hazardous chemicals by strictly adhering to the required personal protection equipment and decontamination procedures.

Engineering controls for fugitive emissions involve spraying a fine mist of water on the area, or curtailing or adjusting operations in the area.

Care will be taken to prevent equipment contamination as much as possible. Sampling and monitoring equipment will not be laid on contaminated surfaces. Monitoring equipment which cannot be decontaminated easily will be bagged, and the bag taped and secured around the instrument. Openings will be made in the bag for sample intake and exhaust ports.

## 2.6 Work/Rest Schedule

The recommended work/rest schedule for the expected (moderate-to-cold with possible rain) weather conditions is:

|        |   |       |
|--------|---|-------|
| 2 hrs  | - | work  |
| 15 min | - | rest  |
| 2 hrs  | - | work  |
| 45 min | - | lunch |
| 2 hrs  | - | work  |
| 15 min | - | rest  |
| 2 hrs  | - | work  |
| 15 min | - | rest  |
| 2 hrs  | - | work  |

The work/rest schedule will be modified if Level B protection is necessary, or if excessively hot or cold temperatures are encountered. Daily work/rest break schedule will be posted at the command post based upon anticipated weather conditions.



## 2.7 Buddy System

Team members will enter the exclusion zone in groups of at least two (buddy system) when wearing respiratory protection. In addition, a third person will standby at the hot line when team members are on-site in Level B protection. Level B protective equipment will be ready and immediately available for use by the standby person, should it become necessary.

## 2.8 Sampling Procedures

Sampling procedures are discussed in detail in the Sampling Plan. Sampling personnel are expected to be familiar with the contents of the Sampling Plan as well as this Health and Safety Plan. Some safety concerns are mentioned below to stress their importance.

- At no time will sampling personnel be allowed to walk on top of drums to gain sampling access.
- Drums and tanks will be opened using a brass non-sparking punch attached to the excavator bucket.
- Field sampling personnel are not allowed to open or enter waste containers without authorization from the site safety officer.
- If a larger opening needs to be made in the drum or tank, the atmosphere within the drum will first be tested for flammable/explosive vapors.
- Access to the interior of the utility lines will be gained using a brass non-sparking punch attached to the excavator bucket.

## 2.9 Heavy Equipment Operation

Only trained equipment operators will be allowed to operate heavy equipment on-site. The number of people near heavy equipment operations and in contaminated areas will be minimized to only those directly involved in the activity. Those not directly involved will be outside a 30-foot radius surrounding the activity.

## 2.10 Mobilization Contacts

The site safety officer will contact the following local agencies during the mobilization phase of the operation:

Valley Medical Center  
400 S. 43rd St.  
Renton, WA  
Phone: (206) 228-3450, Ext. 5789  
Contact: Emergency Room Supervisor  
Alidene Stover

Kent Fire Department  
Fire Station #6  
68th Ave. and 212th St.  
Kent, WA  
Phone: (206) 852-2121  
Contact: Chief Norm Angelo - Fire Chief  
Chief Marvin Berg - Hazmat Team Coordinator  
Chief William LaBore - Crew Coordinator

Medic One Ambulance/Paramedic Station  
400 S. 43rd  
Renton, WA  
Phone: (206) 852-2121  
Contact: Hokey Overland - Paramedic

Pinkerton Security Systems  
Seattle, WA  
Phone: (206) 448-2378

### 3.0 HAZARD INFORMATION

#### 3.1 General Hazard Checklist

Existing Information for Site: detailed x, preliminary    ,  
sketchy    , none    .

Hazardous Material Form/State: gas x, liquid x,  
sludge x, solid x.

Containment: drum x, pit    , pond    , lagoon    , tank  
x, solids x, debris x, landfill x,  
surface impoundment    , soil x, utilities x.

Characteristics: corrosive x, ignitable x, radioactive  
   , volatile x, toxic x, reactive    ,  
other    , unknown x.

#### 3.2 Suspected Hazardous Substances

Numerous organic and inorganic compounds have been detected at the Western Processing site. Compounds present in on-site Area I soils are of particular interest during this investigation, since they may be volatilized or enter the atmosphere as particulates during drilling or excavation activities.

The following list summarizes the maximum concentrations found in on-site soils for a majority of the compounds detected at concentrations greater than 10 ppm. The maximum concentrations occurred either at or below the surface at depths up to 15 feet. The Time Weighted Average (TWA) from the American Conference of Governmental Industrial Hygienists is also included when available, for later reference.



| <u>Parameter</u>     | <u>Max.<br/>Detected<br/>(ppm)</u> | <u>TWA<br/>(mg/m<sup>3</sup>)</u> |
|----------------------|------------------------------------|-----------------------------------|
| Antimony             | 109                                | 0.5                               |
| Arsenic              | 102                                | 0.2                               |
| Cadmium              | 420                                | 0.05                              |
| Chromium             | 7,600                              | 0.5                               |
| Copper               | 5,700                              | 1.0                               |
| Cyanide              | 179                                | 5.0                               |
| Lead                 | 141,000                            | 0.15                              |
| Nickel               | 1,900                              | 1.0                               |
| Zinc                 | 81,000                             | 0.5                               |
| Oxazolidone 130      | ---                                | ---                               |
| Total PAH's          | 53,239                             | 0.2                               |
| Total Phthalates 860 | ---                                | ---                               |
| PCBS                 | 114                                | 1.0                               |

| <u>Parameter</u>      | <u>Max.<br/>Detected<br/>(ppm)</u> | <u>TWA<br/>(ppm)</u> |
|-----------------------|------------------------------------|----------------------|
| 1,1,1-Trichloroethane | 174                                | 350                  |
| Tetrachloroethene     | 72                                 | 50                   |
| Trichloroethene       | 580                                | 50                   |
| Toluene               | 394                                | 100                  |
| Chloroform            | 18                                 | 10                   |
| 2,4-Dimethylphenol    | 11                                 | --                   |
| Phenol                | 27                                 | 5                    |

The above list is included to provide a working base from which site hazard conditions can be evaluated; however, it is not a complete list of all the contaminants that could be in the soil.

Numerous contaminants are present in the groundwater at the site. Unknown contaminants may also be present on-site. Drums of dioxin have been previously found on-site, and the possibility exists that further dioxin-contaminated material may be found.

### 3.3 Overall Hazard

The degree of overall hazard depends on the activity being performed, the contaminants encountered, and the amount of dust and/or vapors generated during activities. Air monitoring will be conducted to ensure that hazards do not exceed the expected hazard level.

Low overall hazard is expected for team members involved in the geophysical survey (remote sensing surveyors). Low overall hazard is also expected for non-intrusive technicians and on-site personnel (runners) who remain outside the 30-foot radius surrounding intrusive activities.

Low-to-moderate hazard is expected for team members collecting surface soil samples, drilling soil borings and collecting soil samples, and excavating exploration sites and collecting soil samples.

Moderate-to-high hazard is expected for team members excavating and sampling buried drums, tanks, and utilities.

#### 4.0 SITE DESCRIPTION

##### 4.1 Site Location

The site is located in the city of Kent approximately four miles north of the central business district. Figure 4.1.1 contains a location map showing Kent and surrounding cities. Figure 4.1.2 contains a vicinity map for the area around the site. The site lies in Section 1, Township 22N, Range 4E, Willamette Meridian. The entrance is at latitude 47°25'37"N, Longitude 122°14'13"W. The site address is 7215 South 196th Street.

##### 4.2 Site Areas

The site is divided into ten areas, as shown in Figure 4.2. Areas I and VII incorporate the Western Processing property; Area I is fenced. The remaining areas are referred to as "off property" areas, but are designated as "on-site" for this Health and Safety Plan.

Area I contains an operations trailer, a storm water treatment plant, several enclosed storage vans, one each plastic-lined and asphalt lined impoundment, and asphalt paving and concrete slabs. Area I may contain ponded water after some rainfall events.

Area II consists of a narrow drainage ditch. A gas pipeline currently in use is buried beneath the ditch at an undetermined shallow depth. Ponding may occur in this ditch.

Area III consists of a large open field. A natural swale cuts across the northeast corner of Area III.

Area IV is a flat area in the southwest corner of the site.

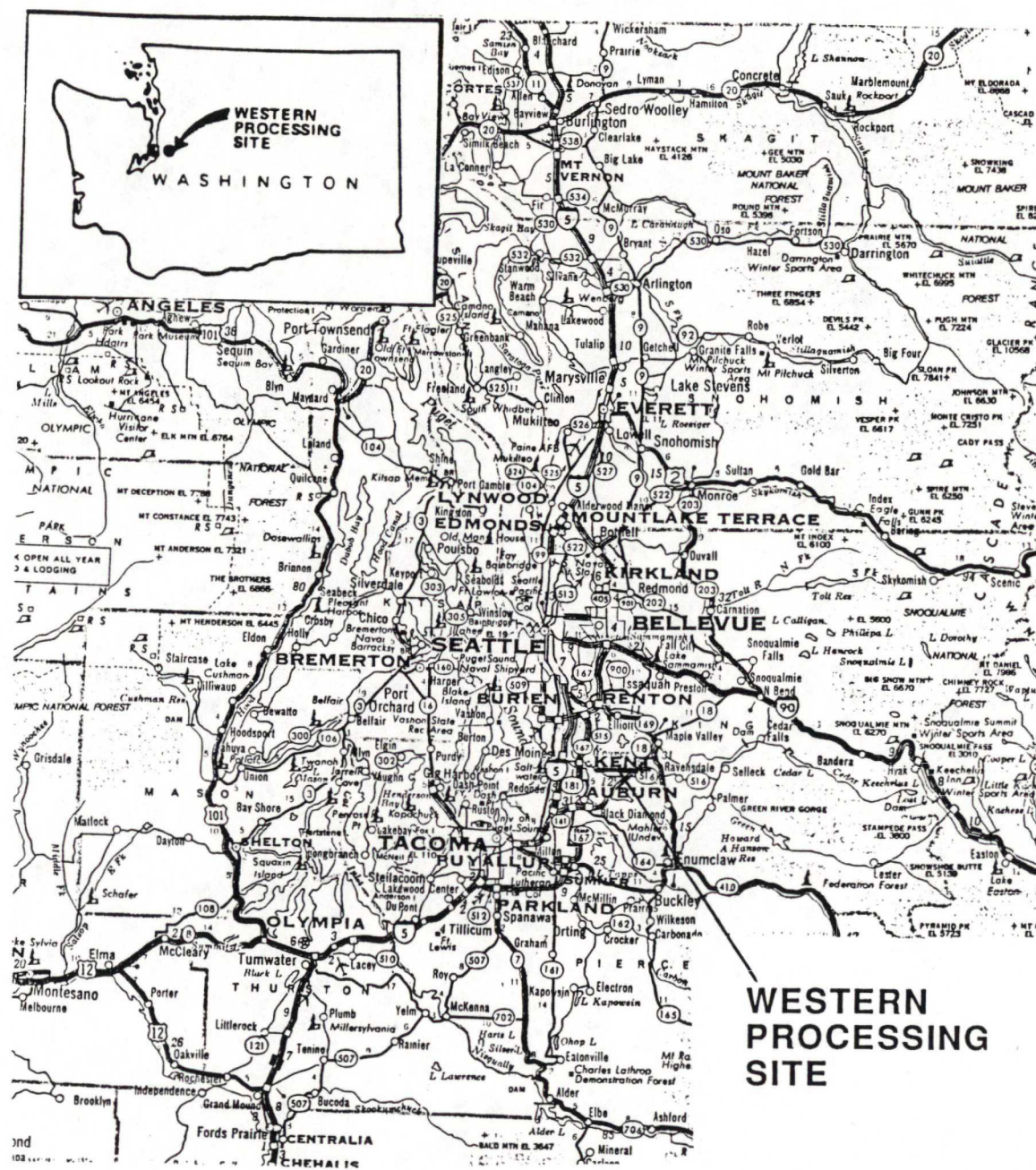
Area V is littered with large vehicles and stacks of heavy construction materials.

Area VI is separated from Area V by Mill Creek. The bridge crossing Mill Creek between the two areas should not be used because it is structurally unsound.

Area VII has been filled twice during the site investigation process. Both gravel and dirt have been introduced from outside sources.



**FIGURE 4.1.1**  
**LOCATION MAP**



SCALE: 1" = 20 miles

FIGURE 4.1.2  
VICINITY MAP

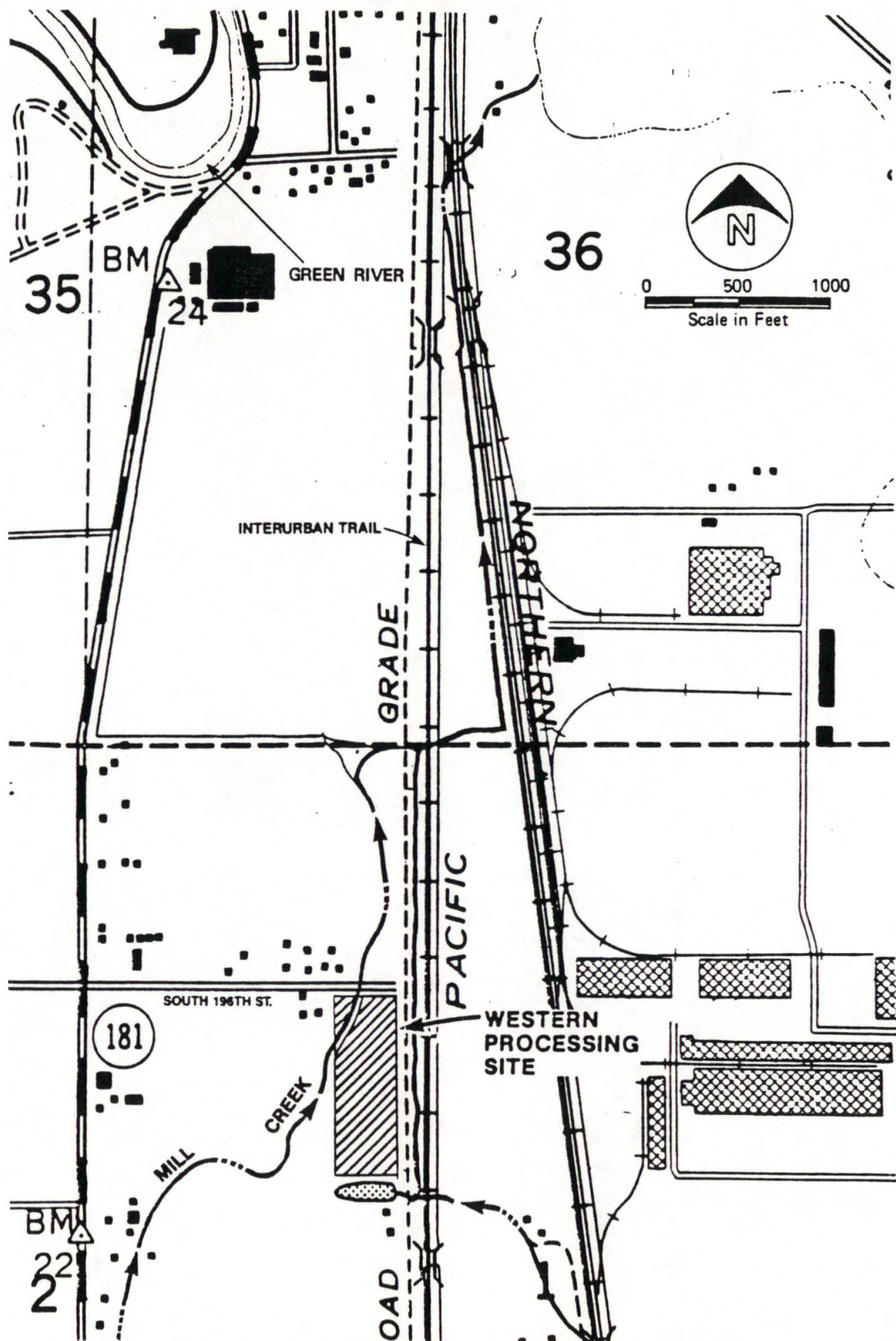
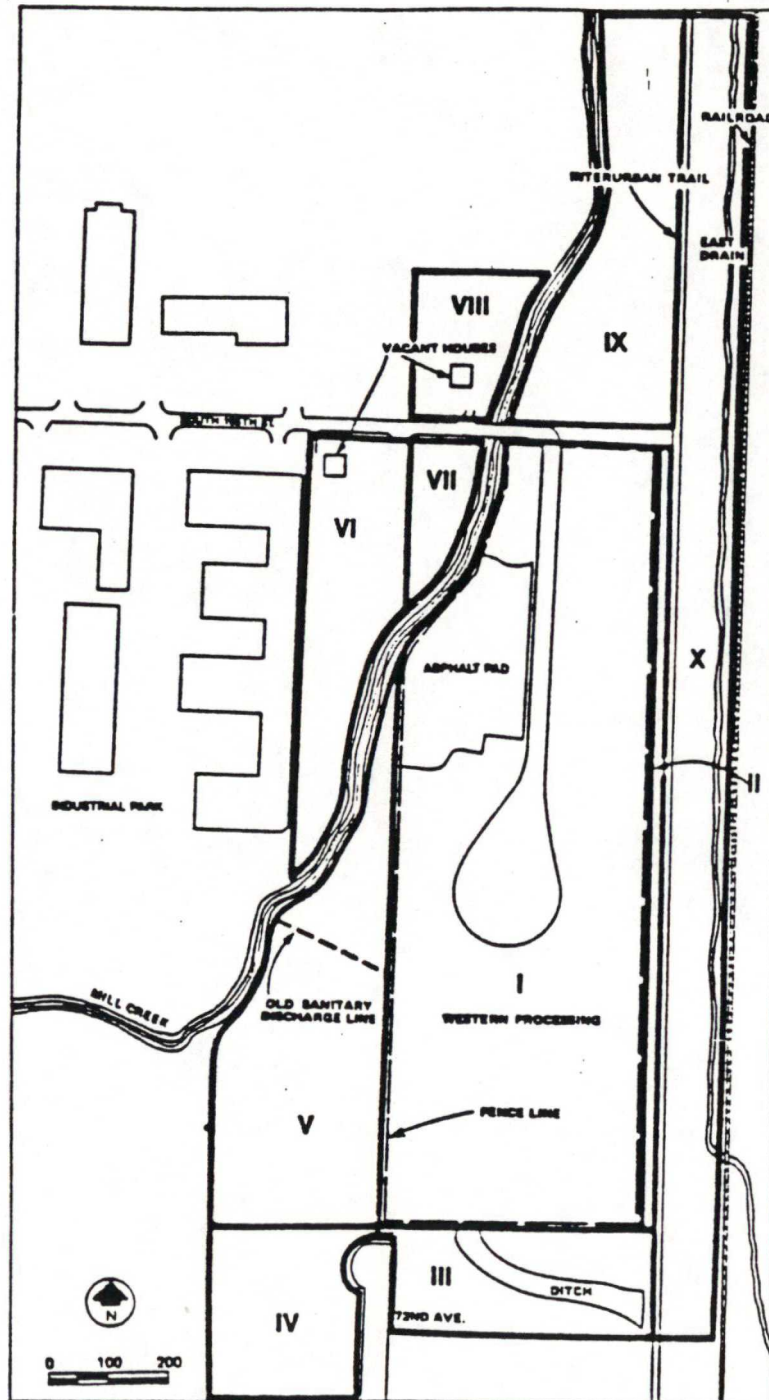




FIGURE 4.2  
SITE AREAS



Area VIII contains a couple of empty buildings, a large field to the north, an access road, and general storage area.

Area IX lies directly north of South 196th Street across from Area I. The area across from the Western Processing gate has been filled. Large amounts of construction debris have been dumped near the Interurban Trail.

Area X lies between the Interurban Trail and the railroad tracks. A high voltage power line runs along the entire length of Area X. Ponding may occur in this area.

#### 4.3 Perimeter Identification

A chain link fence has been constructed around Area I. The main gate for the fence is located on the north side and is staffed by a security guard.

#### 4.4 Existing Geographic Features

Mill Creek, also known as King County Drainage Ditch No. 1, traverses the northwest corner of the site. A natural swale cuts across the northeast corner of Area III. The Kent Bicycle Trail occupies a former railroad right-of-way east of Area I. A drainage ditch also parallels the eastern boundary.

#### 4.5 Unusual Features

An underground gas line (Area II) and an overhead high voltage power line (Area X) are present on-site, as discussed in Section 4.2.

#### 4.6 Topography

The site lies in the flood plain of the Duwamish/Green River. The area is very flat, with an average elevation of approximately 20 feet above sea level.

#### 4.7 Status of Site

The site is closed and has restricted access to Area I.

#### 4.8 Security Measures

A security guard will be present 24 hours-a-day at the main gate of the perimeter fence. Only those persons with approved badges or listed on the approved visitors list will be allowed within the fenced area.

#### 4.9 Expected Weather Conditions

The expected weather conditions are moderate-to-cold with possible rain. According to data compiled by the National Oceanic and Atmospheric Administration (NOAA), the mean

temperature and precipitation in the City of Kent for the months of September through December are as follows:

|           | Temperature<br>____(°F)____ | Precipitation<br>____(inches)____ |
|-----------|-----------------------------|-----------------------------------|
| September | 59.6                        | 2.05                              |
| October   | 51.7                        | 3.47                              |
| November  | 43.8                        | 5.68                              |
| December  | 40.5                        | 6.48                              |

NOAA data for the Seattle-Tacoma Airport show that winds blow predominantly from the southwest in the winter, with an occasional, severe winter storm bringing strong winds from the north.

## 5.0 SITE LAYOUT

### 5.1 General Organization

The site layout will consist of an exclusion zone, contamination reduction zone, and support zone. Each zone represents an established, clearly delineated, posted area.

Area I contains the "support zone" and the "contamination reduction zone." The rest of Area I will be designated as an "exclusion zone." The off-property areas (II-V and VII-X) will be designated as "exclusion zone" during periods of investigation and sampling activities within those areas.

Site zones may require modification during on-site activities. A diagram of the site work zones is presented in Figure 5.1.

### 5.2 Exclusion Zone

Only field team members and authorized visitors will be allowed in the exclusion zone.

The level of protection required in the exclusion zone depends on the activities being conducted, and may change if conditions change. The required level of protection is discussed in Section 6.2.

### 5.3 Contamination Reduction Zone

The contamination reduction zone will include both personnel and equipment decontamination. This area prevents the transfer of contaminants from the exclusion zone to the support zone. The location of the contamination reduction zone is shown in Figure 5.1 as "Decon Line," and will be marked with stakes and brightly colored tape.



A minimum of Level D modified equipment will be worn by those assisting with decontamination.

#### 5.4 Support Zone

The support zone will be located in the northwest part of Area I. The following functions and services will be available in the support zone:

- Command Post (HDR Trailer)
- Decontamination Trailer (HDR)
- On-site Laboratory

In locating this support zone, accessibility, wind direction and line of sight-to-work area were considered. It may be necessary to move the support zone as the conditions change. The location of the support zone is shown in Figure 5.1.

This zone is modified to create suitable conditions for the support zone. A protective layer of crushed rock prevents direct contact with surface material. In addition, daily scanning of the area with air monitoring instruments and strict adherence to exclusion boundaries around subsurface explorations, boreholes, and buried tanks, drums, and utilities sampling will minimize risks of airborne contamination.

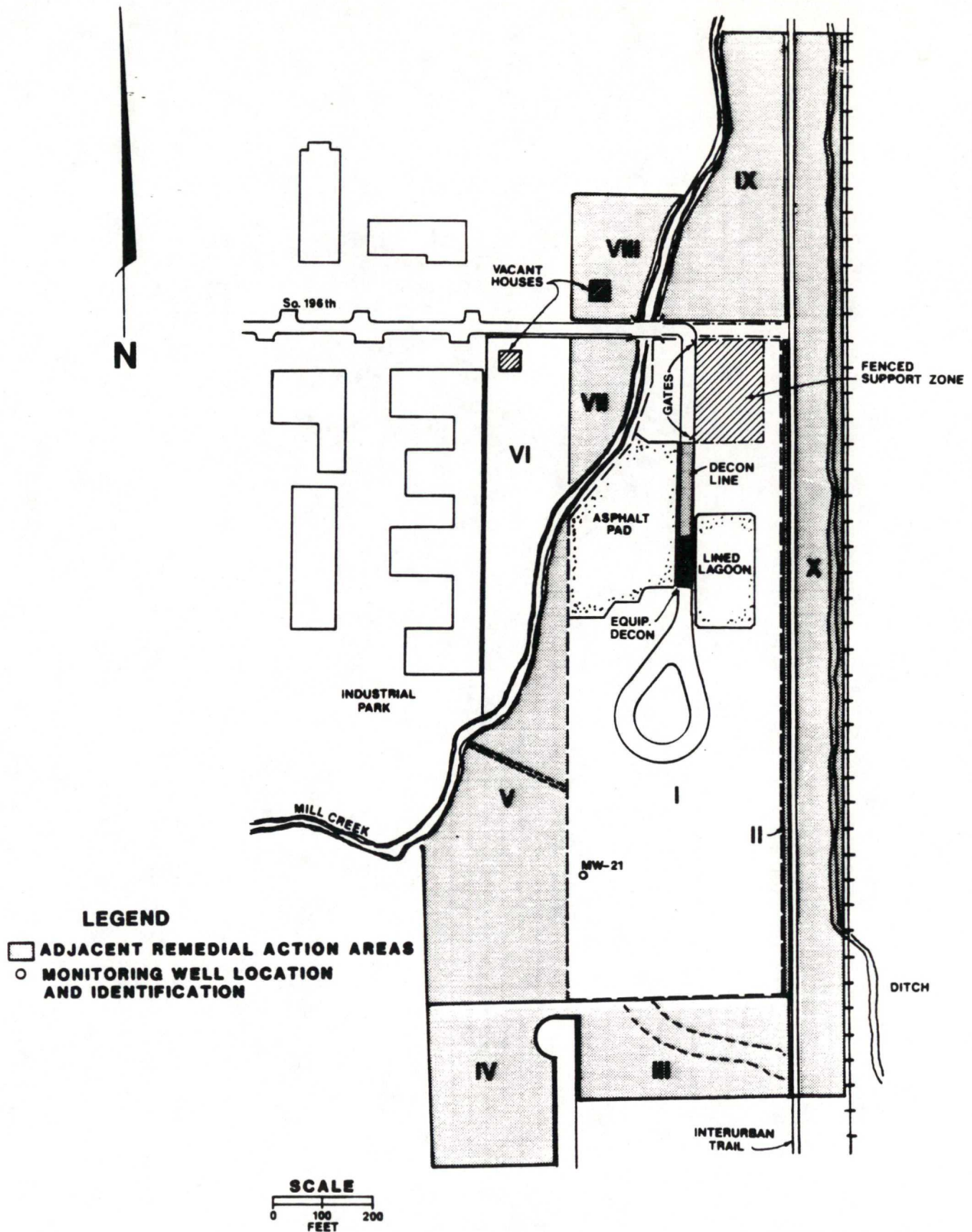
### 6.0 PERSONAL PROTECTIVE EQUIPMENT

#### 6.1 Description of Levels of Protection

Levels of protection have been defined by EPA in the EPA Standard Operating Guide, 1984. Level A is a totally encapsulated chemically protective suit with self-contained breathing apparatus. Level B provides maximal respiratory protection by the use of supplied air or self-contained breathing apparatus, and dermal protection is selected on the basis of anticipated hazards. Level C incorporates an air purifying respirator which is specific to the contaminants of concern. The degree of dermal protection depends on anticipated hazards. A five-minute, supplied air, escape pack will be required while in Level B and Level C. Level D is basically a work uniform. There are numerous variations and modifications possible with each level.

#### 6.2 Action Levels for Required Protection

Table 6.2 lists action levels for both engineering controls and upgrading personal protective equipment. The instrument readings listed in Table 6.2 are sustained readings of one minute or more. The action listed applies to the area within the 30-foot radius where the contaminants were measured, if applicable.



HDR Infrastructure, Inc.  
A Centerra Company

Date  
**9/2/86**

Sheet  
**FIGURE  
5.1**



Copies of Table 6.2 will be posted at the command post, in the contamination reduction zone, and will be given to air monitoring personnel.

Level D modified personal protective equipment will be worn by all personnel outside a 30-foot radius of intrusive activities, as long as action levels for upgrading to Level C protection are not exceeded. At a minimum, Level C protective equipment will be worn by all personnel involved in intrusive activities. Action levels for upgrading to Level B protective equipment are listed in Table 6.2 for each of the air monitoring instruments. If contaminant levels consistently do not exceed the Level D protection requirements during certain intrusive activities, it may be possible to downgrade to Level D modified for those activities. However, the health and safety officer and corporate health and safety officer must approve a downgrade of any intrusive activities to Level D modified.

The health and safety officer will notify the corporate health and safety officer every time an action level is exceeded, thereby requiring that personnel on-site upgrade their level of personal protective equipment or evacuate an area.

Respirator cartridges will be changed daily, or more often if wearers experience labored breathing.

### **6.3 Equipment for Levels of Protection**

The equipment required for the various levels of protection expected on-site are listed below. Table 6.3 contains a summary equipment table. Operating instructions for the personal protective equipment can be found in Appendix C to this document.

#### **Level D - Modified**

- Underclothing
- Hooded one-piece disposable polyethylene coveralls
- PVC inner-disposable gloves
- Neoprene outer gloves
- Neoprene steel toe and shank outer boots (or steel toe leather work boots)
- Chemical resistant disposable boot covers
- Hard hat (with splash shield if liquids encountered)

#### **Level C - Full facepiece high efficiency/OVAG particulate respirator**

- Level D modified equipment
- Full facepiece high efficiency/OVAG particulate respirator
- 5-minute supplied air escape pack

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TABLE 6.2  
ACTION LEVELS

| <u>INSTRUMENT</u> | <u>READING*</u>  | <u>ACTION</u>                                     | <u>LEVEL OF PROTECTION</u> |
|-------------------|--|---|----------------------------|
| HAM               | Background to 0.05 mg/m <sup>3</sup><br>above background                           |   | Level D modified           |
| HAM               | 0.05 mg/m <sup>3</sup> above background to<br>2 mg/m <sup>3</sup> above background | Engineering Controls<br>Upgrade Protective Equip. | Level C                    |
| HAM               | 2 mg/m <sup>3</sup> above background to<br>5 mg/m <sup>3</sup> above background    | Engineering Controls<br>Upgrade Protective Equip. | Level B                    |
| HAM               | 5 mg/m <sup>3</sup> above background<br>or higher                                  | Engineering Controls<br>Evacuate Area             | Evaluate use of Level A    |
| HNU or OVA        | Background to 4 ppm<br>above background  |   | Level D modified           |
| HNU or OVA        | 4 ppm above background to<br>50 ppm above background                               | Engineering Controls<br>Upgrade Protective Equip. | Level C                    |
| HNU or OVA        | 50 ppm above background to<br>1000 ppm above background                            | Engineering Controls<br>Upgrade Protective Equip. | Level B                    |
| HNU or OVA        | 1000 ppm above background<br>or higher   | Engineering Controls<br>Evacuate Area             | Evaluate use of Level A    |

\* Sustained reading lasting one minute or more.

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TABLE 6.2 (Continued)

| <u>INSTRUMENT</u>                  | <u>READING*</u>   | <u>ACTION</u>                                     | <u>LEVEL OF PROTECTION</u> |
|------------------------------------|---|---|----------------------------|
| CN Tubes or<br>Monitox Compur 4100 | Background to 2 mg/m <sup>3</sup><br>above background                             |   | Level D modified           |
| CN Tubes or<br>Monitox Compur 4100 | 2 mg/m <sup>3</sup> above background to<br>10 mg/m <sup>3</sup> above background  | Engineering Controls<br>Upgrade Protective Equip. | Level C                    |
| CN Tubes or<br>Monitox Compur 4100 | 10 mg/m <sup>3</sup> above background to<br>50 mg/m <sup>3</sup> above background | Engineering Controls<br>Upgrade Protective Equip. | Level B                    |
| CN Tubes or<br>Monitox Compur 4100 | 50 mg/m <sup>3</sup> above background<br>or higher                                | Engineering Controls<br>Evacuate Area             | Evaluate use of Level A    |
| OVA                                | Higher reading than HNU reading<br>or High OVA reading                            | Monitor with Methane Tubes                        |                            |
| Methane Tubes                      | Any Color Change  | Monitor with Gas Tech<br>Model GX-82              |                            |
| Gas Tech Model GX-82               | 25% LEL in open area  | Evacuate Area                                     |                            |
| Gas Tech Model GX-82               | 10% LEL in confined spaces  | Do not tamper with<br>container                   | Level B                    |
| Ludlum Model 19                    | Background to 10 mR/hr  | Notify site safety officer<br>Use caution         | Level D modified           |
| Ludlum Model 19                    | 10 mR/hr or higher  | Evacuate Area<br>Notify site safety officer       |                            |

\*Sustained reading lasting one minute or more.



TABLE 6.3  
PERSONAL PROTECTIVE EQUIPMENT

| Equipment   | Number   | Material      | Manufac-<br>turer** | Approval<br>Number |
|---|----------|---------------|---------------------|--------------------|
| Underclothing                                     | 1/person | cotton        | N/A                 | N/A                |
| Coveralls, disposable<br>One-piece, hooded        | *        | tyvec         | N/A                 | N/A                |
| Inner-gloves                                      | *        | PVC           | N/A                 | N/A                |
| Outer gloves                                      | 1/person | Neoprene      | N/A                 | N/A                |
| Boots, steel toed and shank                       | 1/person | Neoprene      | N/A                 | N/A                |
| Boot covers                                       | *        | regular Tyvek | N/A                 | N/A                |
| Hard hat  | 1/person | plastic       | N/A                 | N/A                |
| Protective Goggles<br>(splash proof)              | 1/person | plastic       | N/A                 | N/A                |
| Splash shield                                     | 1/person | plastic       | N/A                 | N/A                |
| Escape mask-5 min.                                | 1/person | N/A           | Scott<br>Skat-Pak   | TC-13F-181         |
| Full facepiece Respirator<br>OVAG-High Efficiency | 1/person | N/A           | Scott               | TC-23C-251         |
| Particulate Cartridges                            | *        | N/A           | Scott               | TC-23C-251         |
| Ear plugs   | *        | N/A           | Deci-Damp           | N/A                |

\* As many as necessary

\*\* Or equivalent

### Level B

- Level D modified equipment
- Self-contained breathing apparatus (SCBA)
- 5-minute supplied air escape pack

## 6.4 Justification of Personal Protective Equipment Selection

Level D modified personal protective equipment is required for personnel involved in non-intrusive activities to minimize contamination of those parts of the body that could possibly come in contact with contaminated surfaces (feet, hands, knees).

As shown in Table 6.2, Level C personal protective equipment is required if the HAM registers between  $0.05 \text{ mg/m}^3$  and  $2 \text{ mg/m}^3$  above background. These particulate concentrations are based on the TWA of cadmium ( $0.05 \text{ mg/m}^3$ ), and the TWA times 40, a conservative estimate of the protection factor for a full facepiece high efficiency/OVAG particulate respirator. Level C protection is also required if the OVA and/or HNU reading falls between 4 ppm and 50 ppm above background. These concentrations are based on the TWA of phenol, which is 5 ppm. Phenol is readily detected on the OVA and the HNU with a 10.2 eV probe. A sustained cyanide concentration of between  $2 \text{ mg/m}^3$  and  $10 \text{ mg/m}^3$  above background requires upgrading to Level C protection based on its TWA of  $5 \text{ mg/m}^3$ .

Upgrading to Level B personal protective equipment is required if the HAM registers between  $2 \text{ mg/m}^3$  and  $5 \text{ mg/m}^3$  above background. An upper limit of  $5 \text{ mg/m}^3$  was selected because that is the lowest of the upper limits recommended for Level B protection with PCBs. An upper limit of 1,000 ppm above background registered by the OVA and/or HNU for Level B protection was based on a protection factor of 200 for the SCBA (again with phenol), which is conservative. An upper cyanide concentration of  $50 \text{ mg/m}^3$  for Level B protection is usually recommended.

## 7.0 DECONTAMINATION

### 7.1 Personnel in Charge

The health and safety officer will be in charge of decontamination. The health and safety officer will be trained in and familiar with the steps of decontamination and will be present for all decontamination. All personnel assisting with decontamination will be equipped with at least Level D modified personal protective equipment.

### 7.2 Decontamination Facilities

Equipment decontamination and the outside line for personal decontamination will be located as shown on Figure 5.1. A decontamination trailer for thorough body decontamination will



be located in the support zone. All wastewater from the decontamination trailer will be treated by the on-site surface water treatment system. Additional decontamination equipment is shown in Table 7.2.

### 7.3 Personal Decontamination

Figure 7.3 illustrates the decontamination layout that will be used at the Western Processing Site. Decontamination procedures to be followed in different situations are discussed below. Decontamination procedures will also be followed if a team member becomes grossly contaminated, or if the protective clothing tears.

#### 7.3.1 Exit Contamination Reduction Zone

A team member departing the Contamination Reduction Zone for a break or lunch will follow this decontamination procedure.

Station 1: Segregated Equipment Drop - Drop equipment onto plastic liner.

Station 2: Boot Cover and Outer Glove Wash/Rinse and Removal - Remove and discard disposable boot covers in storage drum. Wash and rinse outer gloves with detergent and tap water. Remove and deposit outer gloves in plastic bag for further decontamination.

Station 3: Boot Wash/Rinse and Suit Removal - Wash and rinse safety boots. Remove and discard disposable suit into storage drum.

Station 4: Inner Glove Wash/Rinse - Wash and rinse inner gloves.

Station 5: Respirator Removal - Remove, decontaminate, and sanitize respirator. Place on table. (If Level B, decontaminate backpack assembly and place on table).

Station 6: Remove Boots and Inner Gloves - Remove and decontaminate boots. Remove and discard inner gloves in plastic bag.

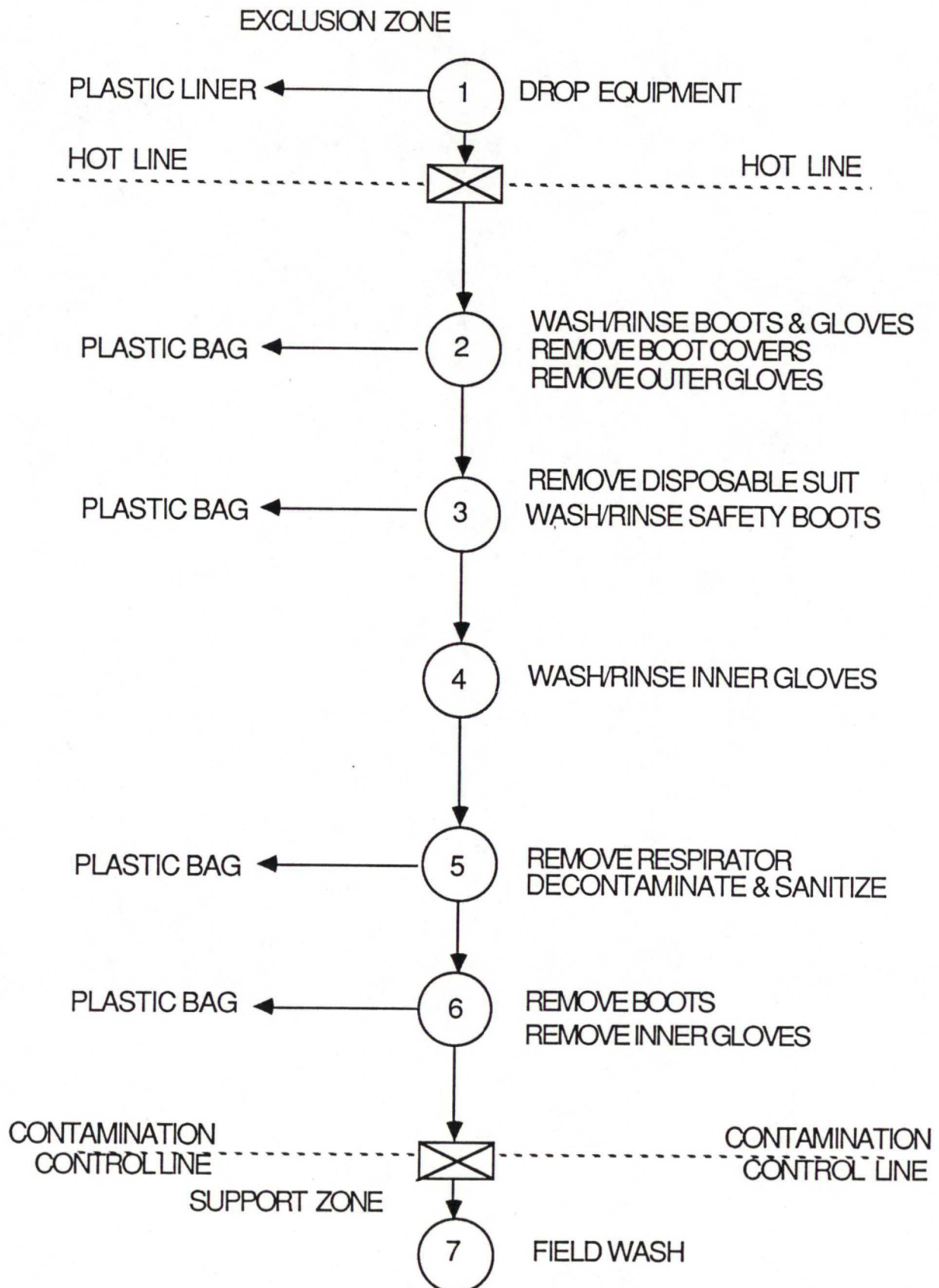
Station 7: Field Wash - Wash hands and face with tap water. A team member departing the contamination reduction zone for the day must then enter the decontamination trailer and shower thoroughly.



TABLE 7.2  
DECONTAMINATION EQUIPMENT

| Equipment           | Number   | Description                  |
|---------------------|----------|------------------------------|
| Tap water           |          |                              |
| Detergent           | 1 gallon | Alconox liquid               |
| Solvent             | 1 gallon | Methanol                     |
| Containers          | 2        | 55-gallon drum               |
| Plastic liners      | 3 dozen  | Various sizes                |
| Plastic drop cloths | 1 dozen  | Large                        |
| Scrub brushes       | 3        | Soft bristle                 |
| Tubs                | 4        | Plastic                      |
| Stool               | 2        | --                           |
| Bucket              | 2        | Plastic                      |
| Pressure sprayer    |          | 5 gallon                     |
| Steam Ginny         |          | 1000 psi fed from tank truck |

**DECONTAMINATION LAYOUT  
LEVEL C PROTECTION  
FIGURE 7.3**



#### 7.3.2 Respirator Change or Work Break

A team member changing a respirator cartridge or taking a break without leaving the Contamination Reduction Zone will follow this shortened decontamination procedure:

Station 1: Segregated Equipment Drop

Station 2: Boot Cover and Outer Glove Wash/Rinse and Removal

Station 3: Boot Wash/Rinse

Station 4: Inner Glove Wash/Rinse and Inner Glove Removal

Station 5: Field Wash

#### 7.3.3 Pick Up/Drop Off Tools

A worker leaving the Exclusion Zone to pick up or drop off tools or instruments and immediately returning will not require decontamination. All equipment, however, will be decontaminated before leaving the exclusion zone.

#### 7.3.4 Emergency Decontamination

If possible, gross decontamination procedures will be speedily implemented in the case of an emergency. If a life-threatening injury occurs and the injured person cannot undergo decontamination procedures without incurring additional injuries, he or she will be transported wrapped in a blanket. The medical facility will be informed that the injured person has not been decontaminated. These arrangements will be prescreened with the medical facility prior to commencing work.

#### 7.3.5 Sanitizing Protective Clothing

Reusable protective clothing becomes soiled due to body oils and perspiration, and consequently must be sanitized as well as decontaminated. If practical, any nondisposable protective clothing will be machine washed after a thorough decontamination; otherwise, it will be cleaned by hand or thrown away.

### 7.4 Equipment Decontamination

#### 7.4.1 Personal Protective Equipment Decontamination

Certain parts of contaminated respirators, such as the harness assembly or cloth components, are difficult to decontaminate. If grossly contaminated, they will be discarded. Rubber components will be soaked in soap and



water and scrubbed with a brush. Respirators will be sanitized by rinsing in a germicidal rinse followed by a clean rinse, then hanging to dry.

Each person will be responsible for decontaminating their own respirators at the end of the day, and will be thoroughly trained in respirator maintenance by the site safety officer.

#### 7.4.2 Sampling Equipment Decontamination

Sampling equipment will be decontaminated prior to any sampling activities, between sampling events, and at the end of sampling activities. Decontamination will consist of detergent wash followed by tap water rinse, solvent rinse, and distilled water rinse. Decontamination procedures are detailed in the Sampling Plan.

#### 7.4.3 Monitoring Equipment Decontamination

All reasonable precautions will be made in order to prevent monitoring equipment from becoming contaminated. If the monitoring equipment does become contaminated, it will be carefully decontaminated according to manufacturer's instructions.

#### 7.4.4 Heavy Equipment Decontamination

Particular care will be taken in decontaminating those portions of the heavy equipment that have come into direct contact with contaminants, such as tracks, tires, shovels, grapples and scoops. All portions of the equipment including the undercarriage, chassis, and cab will be thoroughly cleaned.

For wet decontamination procedures, steam cleaning will be used. Physical scrubbing with disposable brushes will be used when necessary to loosen materials. For frozen contamination where wet procedures may cause operational or maintenance problems, a dry brush removal method will be used. Air filters on equipment utilized in the exclusion zone will be removed and disposed of with the materials used for decontamination. The backhoe bucket and all accessory equipment will be decontaminated between explorations.

The entire excavator will be decontaminated when it is removed from the exclusion zone. The soil borehole drilling rig will be decontaminated during mobilization, after drilling each borehole, and when it is removed from the exclusion zone. The on-site vehicle will be decontaminated before it is removed from the exclusion zone.

### 7.5 Sample Decontamination

Procedures for decontaminating laboratory sample containers and shuttles can be found in the Sampling Plan.

### 7.6 Disposal of Decontamination Fluids and Materials

All materials and equipment used for decontamination will be either cleaned or disposed of according to the following procedures. All nondisposable clothing and equipment will be decontaminated on-site. Disposables will be containerized and left in Area I for disposal by others. Decontamination liquids will be transferred to the impoundment in Area I and treated by the on-site surface water treatment plant with the storm runoff water.

## 8.0 AIR QUALITY MONITORING

### 8.1 Monitoring Equipment

| <u>Equipment</u>  | <u>Use</u>  |
|---|---|
| HNU, Photoionizer<br>Model P1 101 with<br>10.2 eV lamp      | Organic and Inorganic vapors and<br>gases           |
| Foxboro Organic Vapor<br>Analyzer (OVA)<br>Model 108 or 128 | Organic vapors                                      |
| Gastech Personal<br>Three-way Gas Alarm<br>Model GX-82      | Combustible Gas, Oxygen, and H <sub>2</sub> S       |
| Handheld Aerosol Monitor<br>(HAM)                           | Respirable aerosol concentrations                   |
| Ludlum Low Level Gamma<br>Scintillator<br>Model 19          | Gamma Radiation                                     |
| Draeger Colorimetric<br>Tubes                               | Cyanide and Methane<br>Monitox Compur 4100      HCN |

Operating problems may occur with the HNU during rainy or extremely humid conditions. In that case, only the OVA would be used.



## 8.2 Exclusion Zone Monitoring

### 8.2.1 Borehole and Excavation Pit Monitoring

An OVA, and/or HNU, and HAM will be used to monitor the breathing zone at the drill rig and backhoe during subsurface and sampling activities. In addition, cyanide colorimetric tube samples will be obtained at borehole and excavation locations on a regular basis. If high OVA readings are encountered, a combustible gas indicator will be used to determine the possibility of an explosive atmosphere. If high cyanide readings are found, a colorimetric tube will be used at each subsequent borehole and excavation site.

### 8.2.2 Drum/Tank/Utility Monitoring

An OVA, and/or HNU, HAM, radiation detector, combustible gas indicator, cyanide monitor will be used to monitor the breathing zone during operations involving exposure and and sampling of the drums/tanks/ utilities. A combustible gas indicator will also be used to test the atmosphere inside containers for flammable vapors before larger openings in the containers are made.

### 8.2.3 Other Monitoring

An OVA and/or HNU will be used to monitor the breathing zone during surface sampling activities. An OVA or HNU will also be used to monitor the breathing zone during the geophysical survey.

## 8.3 Perimeter and Support Zone Monitoring

Upwind and downwind perimeter and support zone monitoring will be conducted at fixed locations with an OVA, HNU, and HAM before daily operations begin, when elevated readings could possibly be expected due to operation or movement of the excavator or drilling rig, and at the close of daily operations. Perimeter monitoring will also be conducted during emergency conditions, if appropriate. High volume air sampling pumps will be used continuously throughout the project. The monitoring program is explained in detail in the Air Monitoring Plan.

## 8.4 Meteorological Monitoring

A portable meteorological station will be installed on the roof of the command post to provide accurate wind speed and wind direction information. In addition, wind direction indicators (ribbons) visible to on-site personnel will be strategically located throughout the site.



## 9.0 MEDICAL SURVEILLANCE

### 9.1 Medical Facility

HDR and subcontractors are associated with Board Eligible Occupational Medical Physicians.

### 9.2 Medical Examinations

Team members scheduled for on-site activities will have had the medical monitoring outlined in this section.

#### 9.2.1 Initial Exam

The initial exam includes a physical examination, history evaluation, urinalysis, MS-24 (SMAC), complete blood count, ability to wear a respirator, sedimentation rate, electrocardiogram, pulmonary function test (FEV 1 and FVC), 2-view chest X-rays and hearing test. If possible, an approved physician will also determine if the team member is psychologically fit to perform his or her job.

#### 9.2.2 Annual and Exit Exam

The annual and exit exams include a physical examination, toxin exposure history, complete blood count, urinalysis, and MS-24.

#### 9.2.3 Post-Exposure Exam

This exam is highly dependent on the nature and extent of exposure. The post-exposure exam will be administered at the request of the employee and/or the Corporate Health and Safety Officer.

### 9.3 On-Site Team Member Surveillance

The health and safety officer will be trained in recognizing the signs of heat stress, cold exposure, and chemical exposure. The health and safety officer will be responsible for conducting surveillance of the team members during decontamination. Procedures for treating injuries due to heat, cold, or chemical exposure are discussed in Section 10 of this document.

#### 9.3.1 Heat Exhaustion

The main signs of heat exhaustion are:

- Pale, clammy skin;
- Profuse perspiration;
- Extreme tiredness;
- Approximately normal body temperature.

The person may have a headache and may vomit.

### 9.3.2 Heat Stroke

Heat stroke is always life-threatening. In heat stroke, the person stops sweating and consequently their body temperature rises. Brain damage and death will result if the person is not cooled quickly. The main signs of heat stroke are:

- Red or flushed skin;
- Hot dry skin, although the person may have been sweating earlier;
- Extremely high body temperature, often to 106°F.

There may be dizziness, nausea, headache, rapid pulse, and unconsciousness.

### 9.3.3 Frostbite

Frostbite results from freezing a part of the body. The nose, ears, cheeks, fingers, and toes are affected most often. There is often no pain associated with frostbite; the part feels intensely cold and numb. The skin may be slightly flushed just before frostbite occurs. The main signs of frostbite are:

- Skin changes to white or grayish-yellow;
- Pale, glossy skin.

Extremely serious injury can result from frostbite.

### 9.3.4 Exposure to Cold

Death can result from being improperly exposed to cold for a long time. The victim of exposure will undergo the following:

- Sleepy and numb;
- Movement is difficult;
- Eyesight fails.

The person may stagger or fall, and will finally become unconscious.

### 9.3.5 Chemical Exposure

Indicators for possible chemical exposure are:

- Changes in complexion, skin discoloration;
- Lack of coordination;
- Changes in demeanor;
- Excessive salivation, pupillary response;
- Change in speech pattern;

- Headaches;
- Dizziness;
- Blurred vision;
- Cramps;
- Irritation of eyes, skin or respiratory tract.

#### 9.4 Medical Record Keeping

The site safety officer will have access to the physician's certification of medical fitness and medical restrictions for each individual involved. A record containing the health summary form (physician's statement), family member to contact in case of emergency, and special medical concerns such as allergies will be kept on-site for each individual in case of medical emergencies.

Medical records of our team members will be retained by HDR and subcontractors for 30 years after termination of employment, according to Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1910.20).

Exposure records will also be kept for all exposed team members.

### 10.0 EMERGENCY RESPONSE

#### 10.1 Emergency Communication

A number of communication systems will be utilized on-site to supplement normal verbal communications.

##### 10.1.1 Walkie-talkies

Walkie-talkies will be utilized for communication between the site safety officer, command post, and team members within the exclusion zone.

##### 10.1.2 Flags

Color coded flags will be placed within the support area, and will be accessible by all team members. Color coding of the flags will be as follows:

Green - normal operations.

Yellow - halt on-site work until conditions improve; exit exclusion zone.

Red - halt on-site work; exit exclusion zone immediately; evacuate site area.



#### 10.1.3 Hand Signals

The following hand signals will be used by team members:

Thumbs up - OK

Thumbs down - Not OK

Hands on Wrist - Exit exclusion zone

Hands on Throat - Can't breathe

#### 10.1.4 Air Horn

An air horn will be stationed at the command post, and will be used in the following manner.

One long blast: Evacuate zone by nearest emergency exit.

Two short blasts: Localized problem (not dangerous to workers). Workers move to decontamination area for further instructions.

Two long blasts: All clear. Resume work.

#### 10.2 Location of Nearest Phone

Two phones will be located in the support zone at the command post (HDR office trailer). The phone numbers will be:

(206) 251-5278

(206) 251-5712

#### 10.3 On-site Emergency Equipment

Emergency first aid equipment will be located near the command post in the support zone. See Table 10.3 for a complete listing of emergency equipment.

#### 10.4 Off-site Emergency Services

Phone numbers for off-site emergency services are listed in Table 10.4. Table 10.4 will be posted at the command post, in the contamination reduction zone, and in each vehicle.

#### 10.5 Hospital Route

Valley Medical Center is located in Renton. Take 196th Street to West Valley Road (north) to 43rd Street S.W. (east) to Talbot Road (north). Figure 10.5 shows the route to the hospital.

On-site team members will conduct a trip from the site to the hospital during the initial health and safety briefing. At that time, the health and safety officer will record suggested improvements or clarifications to the route.

TABLE 10.3  
ON-SITE EMERGENCY EQUIPMENT

| Equipment                          | Manufacturer              |
|------------------------------------|---------------------------|
| Decontamination Trailer            | --                        |
| Portable eyewash                   | Fendall, 16 gal., 15 min. |
| Water                              | Spray from tank truck     |
| Stretcher                          | --                        |
| First Aid Kit-Industrial           | Johnson & Johnson         |
| Blankets                           | --                        |
| Oxygen Administrator               | MSA                       |
| Fire blanket                       | --                        |
| Fire extinguisher, Type ABC 20 lb. | Ansul                     |
| Fire extinguisher mounting bracket | Ansul                     |
| Long handled shovel                | --                        |
| Two-way radio                      | Midland                   |
| Air Horn-Alert                     | Falcon                    |
| Absorbent Material, 10 bags        | --                        |
| 85 gallon drums                    | --                        |

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TABLE 10.4

EMERGENCY SERVICES

| <u>Service</u>                                       | <u>Name/Location</u>                                   | <u>Phone No.</u> |
|--|--|------------------|
| Ambulance<br>Fire<br>Police                          | Kent Fire Department<br>Kent, WA                       | 852-2121 or 911  |
| Hospital   | Valley Medical Center<br>400 S. 43rd St.<br>Renton, WA | 228-3450         |
| Corporate Health and<br>Safety Officer               | Tracy Coats<br>HDR<br>Omaha, NE                        | 402-399-1284     |
| Poison Control                                       | Children's Hospital &<br>Medical Center<br>Seattle, WA | 526-2121         |
| Washington Dept. of<br>Ecology                       | Northwest Region                                       | 885-1900         |
| Spill Response                                       | EPA Region 10  | 442-1263         |
| Spill Response<br>(24 hour)                          | U.S. Coast Guard                                       | 1-800-424-8802   |
| Natural Gas Response                                 | Washington Natural Gas<br>Seattle, WA                  | 622-6767         |
| Puget Sound Air Pollution<br>Control Agency (PSAPCA) |  | 344-7320         |
| Washington State Patrol                              | Lt. Huss (Bomb Squad)                                  | 753-2191         |

Note: Area code is (206) unless otherwise noted.

Note: Trailer phone number is: 251-5278 or 251-5712.



Figure 10.5 will be posted at the command post, in the contamination reduction zone, and in each vehicle.

#### 10.6 Bodily Injury

Bodily injuries which occur as a result of an accident during the operations at the site will be handled in the following manner:

- The individual will be administered to by an individual who holds current first aid and/or CPR certifications utilizing the emergency equipment on-site.
- The local first aid squad rescue unit, a local hospital (Valley Medical Center, Renton), and the Corporate Health and Safety Officer will be notified of the nature of the emergency.
- The injured employee will be transported by an on-site vehicle to the site boundary where he or she will be transferred to the local emergency vehicle to be transported to the local hospital. As much as practical, on-site vehicles will not leave the site.
- The site safety officer will fill out and submit an Employee Exposure/Injury Incident Report (Appendix B) to the corporate health and safety officer within 24 hours of the accident.

#### 10.7 Injury Due to Heat

The main signs of heat exhaustion and heat stroke are discussed in Section 9.3.

If a person is suffering from heat exhaustion (profuse perspiration, normal body temperature), the following procedures will be undertaken:

- Give half a glass of salt solution (1/2 teaspoon salt in half a glass of water) or Gatorade every 15 minutes for three or four doses.
- Allow person to rest.
- If person is suffering from cramps, press warm, wet towels over the cramped area.

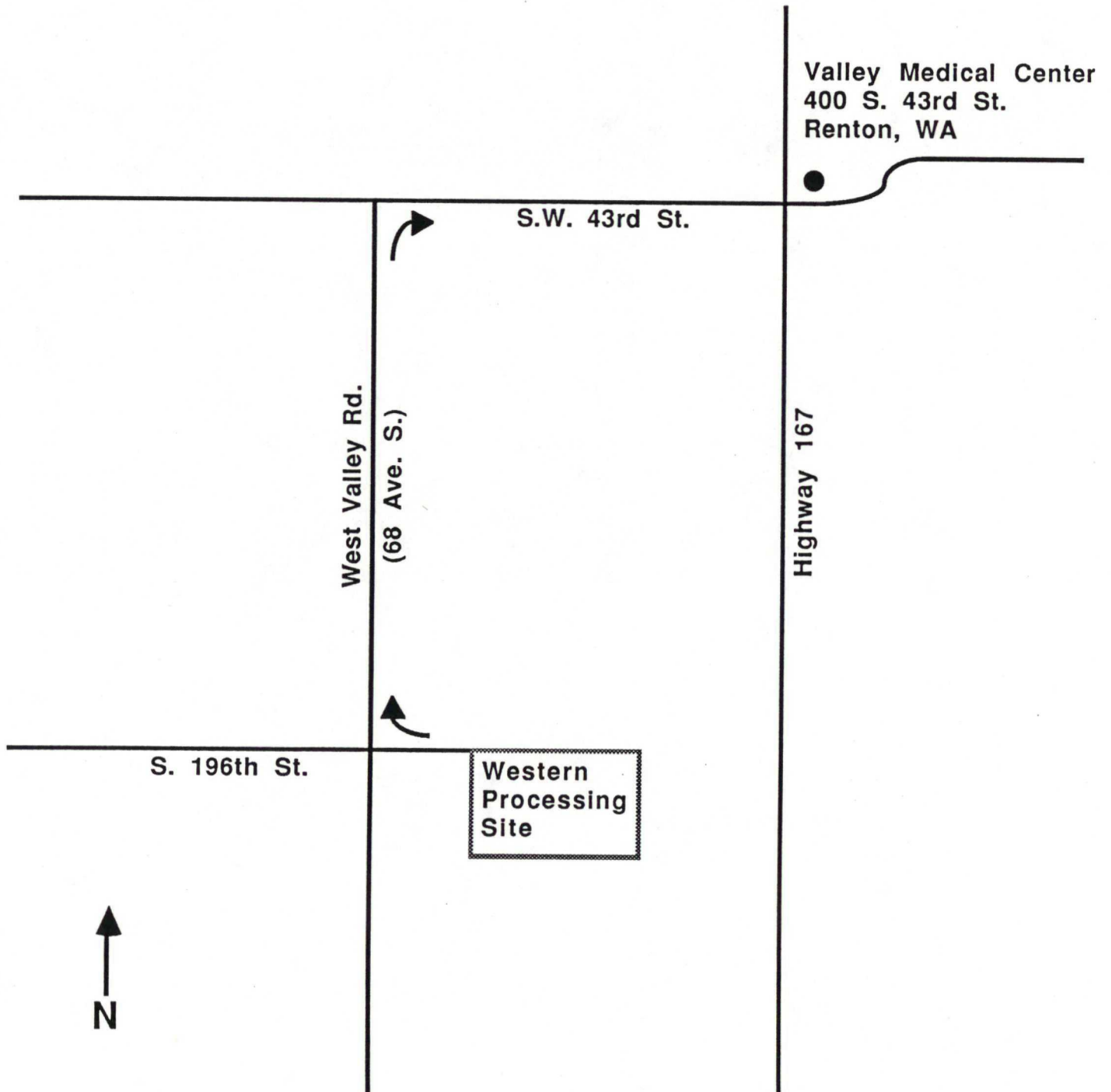
If a person is suffering from heat stroke (skin hot and dry, very high body temperature), the following procedures will be undertaken:

- Cool victim quickly by soaking the person in cool but not cold water, sponging the body with rubbing alcohol or cool water, or pouring water on the body.

Posted

Figure 10.5

# Route to Hospital



- Reduce the body temperature to a safe level (about 102°F), then stop cooling the victim.
- Observe the victim for 10 minutes, and if the body temperature starts to rise again, cool the victim again.
- Get immediate medical care.

#### 10.8 Injury Due to Cold

The main signs of frostbite and exposure to cold are discussed in Section 9.3.

First aid for frostbite consists of the following procedures:

- Bring victim indoors and quickly rewarm the areas in water between 102°F and 105°F.
- Give victim a warm drink - not coffee, tea, or alcohol.
- The victim should not smoke.
- Keep the frozen parts in warm water or covered with warm cloths for 30 minutes, even though the tissue will be very painful as it thaws.
- Elevate the injured area and protect it from injury.
- Cover the injured areas with sterile, soft, dry material.
- Keep the victim warm and get immediate medical care.
- Do not rub the frostbitten part.
- Do not allow blisters to be broken.
- Do not use ice, snow, gasoline, or anything cold on frostbite.
- Do not use heat lamps or hot water bottles to rewarm the part.
- Do not place the part near a hot stove.

First aid for improper exposure to cold consists of the following procedures:

- Bring victim into a warm area quickly.
- Remove wet or cold garments.
- Dry the person thoroughly.



- Provide warm, dry clothing or covering.
- Provide rapid but gentle rewarming.
- Give victim a warm drink--not coffee, tea, or alcohol.
- Keep the victim warm and get immediate medical care.

#### 10.9 Injury Due to Chemical Exposure

Indicators for possible chemical exposure are listed in Section 9.3. If it is suspected that a person has suffered from chemical exposure, they should get immediate medical care.

In the event that a person is splashed or excessively contaminated by waste, the following procedures will be undertaken:

Skin Contact - Flush with water. Remove clothing, flush skin. Secure medical attention.

Inhalation - Move person away from area, administer CPR as needed. Secure medical attention.

Ingestion - Secure medical attention.

Eye Contact - Irrigate with water. Secure medical attention.

After the exposed person is stabilized, follow the procedure outlined in Section 10.6.

#### 10.10 Potential or Actual Fire or Explosion

In the event of a fire or explosion at the site the health and safety officer will initiate the following actions:

- Sound the air horn appropriately, depending on the extent of the emergency.
- Evacuate all unnecessary personnel from the area of the fire, to be expanded to the entire site if necessary.
- Designate personnel to attempt to control the fire using methods compatible with the material which has ignited.
- Contact the local fire and police departments informing them of the fire and any injuries that occurred.
- Contact the local hospital of the possibility of fire victims.
- Contact the Washington Department of Ecology (WDOE) and Region 10 U.S. EPA.

- Direct fire department fire fighters to the site of the incident.
- Relay weather and site conditions to the appropriate authorities.

The above fire control procedures are to be followed only with respect to containing small fires. In the event that a fire situation begins to spread rapidly, all personnel will evacuate the site until the fire department arrives.

#### 10.11 Environmental Accident/Contamination Spread

In the event of an emergency or hazardous situation, the health and safety officer will initiate similar actions to those outlined in Section 10.10, except additional outside contacts will have to be immediately made.

A supply of suitable sorbent material will be readily available in case liquid-holding vessels begin leaking. Also, OHM will use overpacks to attempt to containerize any leaking drums or tanks. In the case of a spill which cannot be containerized or exceeds the reportable quantity, Spill Response, EPA Region 10 and U.S. Coast Guard (Table 10.4), will be contacted.

In the event of an off-site release of materials, these additional contacts will be made:

- Kent Police Department
- Puget Sound Air Pollution Control Agency (PSAPCA)
- Washington State Patrol

In the event of the discovery of suspected explosives or damaged gas cylinders, these additional contacts will be made:

- Kent Police Department
- Washington State Patrol Bomb Squad

#### 10.12 Non-operational Hours

Pinkerton Security Systems supplies guards for the guard house. These guards will be notified to contact the Project Manager, Kenneth Lepic, during any non-operational hours emergency. There will be alternate contacts in case Mr. Lepic cannot be reached. All necessary phone numbers will be provided to the security service.

If criminal activity is encountered the security service will contact the Kent Police Department.

## 11.0 TRAINING

All on-site personnel will be required to receive formal health and safety training depending on their project role, as discussed below. Records will be kept by the corporate health and safety officer as to the training status of each on-site team member.

### 11.1 Level D Training

As shown in Table 11.0, remote sensing surveyors will have Level D training.

Level D training consists of attending the initial site-specific health and safety briefing conducted by the health and safety officer during the mobilization phase.

### 11.2 Level C Training

Non-intrusive technicians, on-site technicians (runners), and decontamination personnel will have Level C training.

Level C training is a three day course consisting of lectures, field exercises, and tests. The Level C training outline will include the following minimum items:

- A. Health Effects and Hazards.
  - 1. Site/Work Related Hazards
  - 2. Basic Human Toxicology
  - 3. Health and Safety Terminology
- B. Acceptable Safety Practices
  - 1. Personal Precautions
  - 2. Buddy System
  - 3. Operational Practices
- C. Personal Protection
  - 1. Necessity
  - 2. Effectiveness and Limitations
  - 3. Use of Equipment
  - 4. Protective Clothing
  - 5. Inspection and Checkout
  - 6. Care and Maintenance
  - 7. Donning and Doffing
  - 8. Respiratory Fit Testing
- D. Decontamination
  - 1. Methods
  - 2. Equipment
  - 3. Facilities
  - 4. Disposal Methods
- E. Medical Surveillance
  - 1. Medical Examinations
  - 2. On-Site Surveillance



TABLE 11.0

FIELD TEAM TRAINING REQUIREMENTS

| <u>Contractor</u> | <u>Project<br/>Role</u>             | <u>Training</u> |                |                | <u>CPR</u> | <u>First<br/>Aid</u> | <u>Intrusive</u> | <u>Non-<br/>Intrusive</u> | <u>Health &amp; Safety<br/>Briefing</u> |
|-------------------|-------------------------------------|-----------------|----------------|----------------|------------|----------------------|------------------|---------------------------|---|
|                   |                                     | <u>Level D</u>  | <u>Level C</u> | <u>Level B</u> |            |                      |                  |                           |   |
| HDR               | On-scene<br>Coordinator             | x               | x              | x              | x          | x                    | x                | x                         | x                                       |
| HDR               | Assistant<br>Project Manager        | x               | x              | x              |            |                      | x                | x                         | x                                       |
| HDR               | Project Manager                     | x               | x              | x              | x          | x                    | x                | x                         | x                                       |
| HDR               | Non-Intrusive<br>Technicians        | x               | x              |                |            |                      |                  | x                         | x                                       |
| HDR               | Field Samplers                      | x               | x              | x              | x          | x                    | x                | x                         | x                                       |
| HDR               | Air Monitoring<br>Personnel         | x               | x              | x              | x          | x                    | x                | x                         | x                                       |
| HDR               | On-Site<br>Technicians<br>(Runners) | x               | x              |                |            |                      |                  | x                         | x                                       |
| HDR               | Decontamination<br>Personnel        | x               | x              |                |            |                      |                  | x                         | x                                       |
| HDR               | Site Safety<br>Officer              | x               | x              | x              | x          | x                    | x                | x                         | x                                       |
| HDR               | QA/QC Officers                      | x               | x              | x              | x          | x                    | x                |                           | x                                       |

TABLE 11.0

FIELD TEAM TRAINING REQUIREMENTS

| <u>Contractor</u> | <u>Project<br/>Role</u>              | <u>Level D</u> | <u>Training<br/>Level C</u> | <u>Level B</u> | <u>CPR</u> | <u>First<br/>Aid</u> | <u>Intrusive</u> | <u>Non-<br/>Intrusive</u> | <u>Health &amp; Safety<br/>Briefing</u> |
|-------------------|--------------------------------------|----------------|-----------------------------|----------------|------------|----------------------|------------------|---------------------------|---|
| ETI               | Air Monitoring Technician            | x              | x                           | x              |            |                      | x                |                           | x                                       |
| Nortec            | Remote Sensing Surveyors             | x              |                             |                |            |                      |                  | x                         | x                                       |
| OHM               | Buried Container Samplers            | x              | x                           | x              | x          | x                    | x                |                           | x                                       |
| OHM               | Buried Container Equipment Operators | x              | x                           | x              | x          | x                    | x                |                           | x                                       |
| EEI               | Drillers                             | x              | x                           | x              |            |                      | x                |                           | x                                       |
| EEI               | Geologist                            | x              | x                           | x              |            |                      | x                |                           | x                                       |
| EEI               | Excavation Equipment Operators       | x              | x                           | x              |            |                      | x                |                           | x                                       |

- F. Air Monitoring Equipment
  - 1. Organiz Vapor Analyzers
  - 2. Aerosol Monitors
  - 3. Colorimetric Tube Detectors
  - 4. Combustible Gas Indicator
  - 5. Radiation Meter
- G. Emergencies
  - 1. Emergency Recognition and Prevention
  - 2. Communications
  - 3. Equipment
  - 4. Evacuation Routes and Procedures
  - 5. Emergency Response Procedure
  - 6. Off-Site Support
  - 7. Documentation
- H. Hands-On Training
  - 1. Donning and Doffing Respirator
  - 2. Respirator Maintenance
  - 3. Fit-Testing Respirators
  - 4. Escape Mask Use
  - 5. Wearing Levels D and C
  - 6. Using Air Monitoring Equipment

### 11.3 Level B Training

As shown in Table 11.0, all remaining on-site personnel will be required to have Level B training.

Level B training is a four day course that parallels EPA Training Course 165.5. In addition to the items contained in the Level C training course outline, Level B training will include:

- Checking Out SCBA
- Inspecting SCBA
- Recharging SCBA Air Cylinders
- Donning and Doffing Level B
- Wearing Level B

### 11.4 CPR and First Aid Training

Current CPR and Multi-media First Aid Training will be required for the on-site coordinator and health and safety officer. In addition, at least two other people on-site will also have current certification. All Level B trained HDR employees on-site will have current certification.

### 11.5 On-Site Training

All on-site team members will attend an initial health and safety briefing covering the topics presented in this Health and Safety Plan. The form that will be used to record their attendance and summarize the materials covered during the



initial briefing can be found in Appendix B. Initial health and safety briefings will also be conducted for any new team members coming on-board at a later date. In addition, on-site team members will attend daily health and safety briefings. Appendix B also contains a form to be used to summarize the daily meetings.

Personnel will practice unfamiliar operations prior to entering contaminated zones and conducting the actual procedure.

## 12.0 REFERENCES

### 12.1 General References

- a. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.
- b. Standard Operating Safety Guides, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, November, 1984.
- c. Basic Industrial Hygiene, Richard Brief, American Industrial Hygiene Association, Akron, OH.
- d. Protecting Personnel at Hazardous Waste Sites, S.P. Levine and W.F. Martin, Eds., Butterworth Publishers, 1985.

### 12.2 Physical/Chemical Data References

- a. Handbook of Toxic and Hazardous Chemicals and Carcinogens, Second Edition, Marshall Sittig, Noyes Publications, 1985.
- b. Dangerous Properties of Industrial Materials, Fifth Edition, N. Irving Sax, Van Nostrand Reinhold Company, 1979.
- c. NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, September, 1985.

### 12.3 Other References

- a. Student Workbook for Multimedia Standard First Aid, American Red Cross, 1981.
- b. Climate Normals for the U.S. (Base: 1951-1980), Data compiled by NOAA, Gale Research Co. Pub., 1983.
- c. Dust Control at Hazardous Waste Sites, EPA/540/2-85/003, November, 1985.

# **APPENDIX A**

## **CHEMICAL DATA**



**Incompatibilities:** Strong oxidizers, strong caustics, chemically active metals, such as aluminum, magnesium powders, sodium, potassium.

**Permissible Exposure Limits in Air:** The Federal standard and the 1983/84 ACGIH TWA value is 10 ppm (45 mg/m<sup>3</sup>). The STEL value is 20 ppm (90 mg/m<sup>3</sup>). The notation "skin" is added to indicate the possibility of cutaneous absorption. The IDLH level is 500 ppm.

**Determination in Air:** Adsorption on charcoal, workup with CS<sub>2</sub>, analysis by gas chromatography. See-NIOSH Methods, Set J. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life—18,000 µg/l on an acute toxicity basis and 9,400 µg/l on a chronic basis. To protect saltwater aquatic life—no criteria developed due to insufficient data. To protect human health—preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 6.0 µg/l.

**Determination in Water:** Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

**Routes of Entry:** Inhalation of vapor, absorption through the skin, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** *Local* — Irritation to eyes and nose, and infection of the conjunctiva have been shown in animals.

*Systemic* — Little is known of the toxicity of 1,1,2-trichloroethane since no human toxic effects have been reported. Animal experiments show 1,1,2-trichloroethane to be a potent central nervous system depressant. The injection of anesthetic doses in animals was associated with both liver and renal neurosis. 1,1,2-Trichloroethane is carcinogenic in at least one rodent species (4).

**Points of Attack:** Central nervous system, eyes, nose, liver, kidneys.

**Medical Surveillance:** Consider the skin, central nervous system, and liver and kidney function. Alcoholism may be a synergistic factor. Expired air analyses may be useful in monitoring exposure.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

#### Respirator Selection:

500 ppm: SAF/SCBAF  
Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

#### References

- (1) U.S. Environmental Protection Agency, *Chemical Hazard Information Profile: 1,1,2-Trichloroethane*, Washington, DC (August 1, 1978) (Revised issue 1979).
- (2) U.S. Environmental Protection Agency, *Chlorinated Ethanes: Ambient Water Quality Criteria*, Washington, DC (1980).
- (3) U.S. Environmental Protection Agency, *1,1,2-Trichloroethane*, Health and Environmental Effects Profile No. 165, Washington, DC, Office of Solid Waste (April 30, 1980).
- (4) National Cancer Institute, *Bioassay of 1,1,2-Trichloroethane for Possible Carcinogenicity*, Technical Report Series No. 74, Bethesda, MD (1978).
- (5) See Reference (A-61).
- (6) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 88-90, New York, Van Nostrand Reinhold Co. (1982).
- (7) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 2, 66-69, New York, Van Nostrand Reinhold Co. (1983).
- (8) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 2213-14, Geneva, International Labour Office (1983).
- (9) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. 1, pp VII/325-27, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

### TRICHLOROETHYLENE

- Carcinogen (animal positive, IARC) (6), NCI (7)
- Hazardous substance (EPA)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:** ClCH=CCl<sub>2</sub>, trichloroethylene, a colorless, nonflammable, non-corrosive liquid has the "sweet" odor characteristic of some chlorinated hydrocarbons. It boils at 86° to 87°C.

**Code Numbers:** CAS 79-01-6 RTECS KX4550000 UN 1710

**DOT Designation:** ORM-A

**Synonyms:** Ethylene trichloride, ethinyl trichloride, trichloroethene, tri, TCE.

**Potential Exposures:** Trichloroethylene is primarily used as a solvent in vapor degreasing. It is also used for extracting caffeine from coffee, as a dry-cleaning agent, and as a chemical intermediate in the production of pesticides, waxes, gums, resins, tars, paints, varnishes, and specific chemicals such as chloroacetic acid.

It was estimated by NIOSH in 1973 that 200,000 workers are potentially exposed to trichloroethylene and that many of these exposures are in small workplaces. In 1978, this estimate was revised to 100,000 full-time exposures to TCE with up to 3.5 million more workers subjected to continuous low levels or to brief exposures of various levels.

**Incompatibilities:** Strong caustics; when acidic reacts with aluminum; chemically active metals—barium, lithium, sodium, magnesium, titanium.

Decomposition of trichloroethylene, due to contact with hot metal or ultraviolet radiation, forms products including chlorine gas, hydrogen chloride, and phosgene. Dichloroacetylene may be formed from the reaction of alkali with trichloroethylene.

**Permissible Exposure Limits in Air:** The Federal standard is 100 ppm (535



mg/m<sup>3</sup>) as an 8-hour TWA with an acceptable ceiling concentration of 200 ppm; acceptable maximum peaks above the ceiling of 300 ppm are allowed for 5 minutes duration in a 2-hour period. The NIOSH Criteria for a Recommended Standard (1) recommends limits of 100 ppm as a TWA and a peak of 150 ppm determined by a sampling time of 10 minutes.

It was recommended by NIOSH in 1978 (2) that the permissible limit for occupational exposure to trichloroethylene be reduced and that TCE be controlled as an occupational carcinogen. Current information regarding engineering feasibility indicates that personnel exposures of 15 ppm, on a time-weighted-average, can be readily attained using existing engineering control technology. However, NIOSH does not feel that this should serve as a final goal. Rather, industry should pursue further reductions in worker exposure as advancements in technology research allow.

The ACGIH has recommended as of 1983/84 a TWA value of 50 ppm (270 mg/m<sup>3</sup>) and an STEL of 150 ppm (805 mg/m<sup>3</sup>); consideration is being given to upping the STEL to 200 ppm (1,080 mg/m<sup>3</sup>). The IDLH level is 1,000 ppm.

The Dutch chemical industry (A-60) has set a maximum allowable concentration of 35 ppm (190 mg/m<sup>3</sup>).

**Determination in Air:** Adsorption on charcoal, workup with CS<sub>2</sub>, analysis by gas chromatography. See NIOSH Methods, Set J. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life—45,000 µg/l on an acute toxicity basis. To protect saltwater aquatic life—2,000 µg/l on an acute toxicity basis. To protect human health—preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 27 µg/l.

**Determination in Water:** Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

**Routes of Entry:** Inhalation, percutaneous absorption, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** *Local* — Exposure to trichloroethylene vapor may cause irritation of the eyes, nose, and throat. The liquid, if splashed in the eyes, may cause burning irritation and damage. Repeated or prolonged skin contact with the liquid may cause dermatitis.

*Systemic* — Acute exposure to trichloroethylene depresses the central nervous system exhibiting such symptoms as headache, dizziness, vertigo, tremors, nausea and vomiting, irregular heart beat, sleepiness, fatigue, blurred vision, and intoxication similar to that of alcohol. Unconsciousness and death have been reported. Alcohol may make the symptoms of trichloroethylene overexposure worse. If alcohol has been consumed, the overexposed worker may become flushed. Trichloroethylene addiction and peripheral neuropathy have been reported.

The National Cancer Institute (NCI) in the United States has issued a "state of concern" alert, warning producers, users, and regulatory agencies that trichloroethylene administered by gastric intubation to mice induced predominantly hepatocellular carcinomas with some metastases to the lungs.

**Points of Attack:** Respiratory system, heart, liver, kidneys, central nervous system, skin.

**Medical Surveillance:** Preplacement and periodic examinations should include the skin, respiratory, cardiac, central, and peripheral nervous systems, as well as liver and kidney function. Alcohol intake should be evaluated.

Expired air analysis and urinary metabolites have been used to monitor exposure.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

#### Respirator Selection:

500 ppm: CCROV/SA/SCBA

1,000 ppm: CCROVF/GMOV/SAF/SCBAF

Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. An alternative to disposal for TCE is recovery and recycling (A-58).

#### References

- (1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Trichloroethylene*, NIOSH Doc. No. 73-11025 (1973).
- (2) National Institute for Occupational Safety and Health, *Special Occupational Hazard Review with Control Recommendations: Trichloroethylene*, NIOSH Doc. No. 78-130, Washington, DC (January 1978).
- (3) U.S. Environmental Protection Agency, *Trichloroethylene: Ambient Water Quality Criteria*, Washington, DC (1980).
- (4) U.S. Environmental Protection Agency, *Status Assessment of Toxic Chemicals: Trichloroethylene*, Report EPA-600/2-79-210m, Cincinnati, OH (December 1979).
- (5) U.S. Environmental Protection Agency, *Trichloroethylene*, Health and Environmental Effects Profile No. 166, Washington, DC, Office of Solid Waste (April 30, 1980).
- (6) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France II, 263 (1976).
- (7) National Cancer Institute, *Carcinogenesis Bioassay of Trichloroethylene*, Technical Report Series No. 2, Bethesda, MD (1976).
- (8) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 67-69, New York, Van Nostrand Reinhold Co. (1980).
- (9) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 89-94, New York, Van Nostrand Reinhold Co. (1983).
- (10) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 2214-16, Geneva, International Labour Office (1983).
- (11) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. II, pp VII/367-70, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

cis-N-TRICHLOROMETHYL-THIO-4-CYCLOHEXENE-  
1,2-DICARBOXAMIDE

See "Captan."



Code Numbers: CAS 59-50-7 RTECS GO7100000 UN 2669

DOT Designation: —

Synonym: 4-Chloro-m-cresol.

**Potential Exposures:** p-Chloro-m-cresol is used as an external germicide and as a preservative for glues, gums, paints, inks, textiles and leather goods. It is also used as a preservative in cosmetics. It has been found to be formed by the chlorination of waters receiving effluents from electric power-generating plants and by the chlorination of the effluent from a domestic sewage-treatment facility.

**Permissible Exposure Limits in Air:** No standards set.

**Permissible Concentration in Water:** No criteria set.

**Harmful Effects and Symptoms:** Very little toxicological data for p-chloro-m-cresol are available (1). One source has rated p-chloro-m-cresol as very toxic, with a probable lethal dose to humans of 50 to 500 mg/kg. p-Chloro-m-cresol was also reported as nonirritating to skin in concentrations of 0.5 to 1.0% in alcohol.

#### References

- (1) U.S. Environmental Protection Agency, *p-Chloro-m-Cresol*, Health and Environmental Effects Profile No. 43, Office of Solid Waste, Washington, DC (April 30, 1980).
- (2) See Reference (A-60).

## CHLORODIFLUOROMETHANE

**Description:**  $\text{CHClF}_2$  is a colorless, nearly odorless gas.

**Code Numbers:** CAS 75-45-6 RTECS PA6390000 UN 1018

**DOT Designation:** Nonflammable gas.

**Synonyms:** Difluorochloromethane, difluoromonochloromethane, Propellant 22, Refrigerant 22, Fluorocarbon 22, F-22.

**Potential Exposures:**  $\text{CHClF}_2$  is used as an aerosol propellant, refrigerant and low-temperature solvent. It is used in the synthesis of polytetrafluoroethylene (PTFE).

**Permissible Exposure Limits in Air:** There is no Federal standard, however ACGIH has as of 1983/84 adopted TWA values of 1,000 ppm (3,500 mg/m<sup>3</sup>) and set an STEL of 1,250 ppm (4,375 mg/m<sup>3</sup>).

**Permissible Concentration in Water:** No criteria set.

**Harmful Effects and Symptoms:** In animal studies, stimulation and then depression were produced by concentrations of 100,000 ppm; 200,000 ppm produced narcosis; and death resulted at 300,000 to 400,000 ppm. At 14,000 ppm, pathological changes were noted in the lungs, central nervous system, heart, liver, kidneys and spleen. At 2,000 ppm no effects were noted (A-34).

**Personal Protective Methods:** Wear rubber gloves.

**Respirator Selection:** Use air mask (A-38).

**Disposal Method Suggested:** Vent to atmosphere.

## CHLORODIPHENYL

See "Polychlorinated Biphenyls (PCB's)."

## 2-CHLOROETHYL VINYL ETHER

- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:**  $\text{ClCH}_2\text{CH}_2\text{OCH}=\text{CH}_2$  is a colorless liquid boiling at 109°C.

**Code Numbers:** CAS 110-75-8 RTECS KN6300000

**DOT Designation:** —

**Synonym:** Vinyl 2-chloroethyl ether.

**Potential Exposures:** The compound finds use in the manufacture of anesthetics, sedatives, and cellulose ethers. NIOSH estimates annual exposure at 23,500 workers. The number of potentially exposed individuals is greatest for the following areas: fabricated metal products; wholesale trade; leather, rubber and plastic, and chemical products (1).

**Permissible Exposure Limits in Air:** No standards set.

**Permissible Concentration in Water:** For the protection of freshwater aquatic life: 50,000 µg/l (2). No criteria were developed for saltwater aquatic life or for the protection of human health.

**Determination in Water:** Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

**Harmful Effects and Symptoms:** Very little toxicological data for 2-chloroethyl vinyl ether is available. The oral LD<sub>50</sub> for 2-chloroethyl vinyl ether in rats is 250 mg/kg (moderately toxic). Primary skin irritation and eye irritation studies have also been conducted for 2-chloroethyl vinyl ether. Dermal exposure to undiluted 2-chloroethyl vinyl ether did not cause even slight erythema. Application of undiluted 2-chloroethyl vinyl ether to the eyes of rabbits resulted in severe eye injury.

#### References

- (1) U.S. Environmental Protection Agency, *2-Chloroethyl Vinyl Ether*, Health and Environmental Effects Profile No. 46, Office of Solid Waste, Washington, DC (April 30, 1980).
- (2) U.S. Environmental Protection Agency, *Chloroalkyl Ethers: Ambient Water Quality Criteria*, Washington, DC (1980).

## CHLOROFORM

- Carcinogen (Animal Suspected, IARC) (6)
- Hazardous substance (EPA)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)



**Description:**  $\text{CHCl}_3$ , chloroform, is a clear, colorless liquid with a characteristic odor. Though nonflammable, chloroform decomposes to form hydrochloric acid, phosgene, and chlorine upon contact with a flame.

**Code Numbers:** CAS 67-66-3 RTECS FS9100000 UN 1888

**DOT Designation:** ORM-A, poison.

**Synonym:** Trichloromethane.

**Potential Exposures:** Chloroform was one of the earliest general anesthetics, but its use for this purpose has been abandoned because of toxic effects. Chloroform is widely used as a solvent (especially in the lacquer industry); in the extraction and purification of penicillin and other pharmaceuticals; in the manufacture of artificial silk, plastics, floor polishes, and fluorocarbons; and in sterilization of catgut. The wide industrial usage of chloroform potentially exposes 360,000 workers (OSHA). Chemists and support workers as well as hospital workers are believed to be at a higher risk than the general population.

Chloroform is widely distributed in the atmosphere and water (including municipal drinking water primarily as a consequence of chlorination). A survey of 80 American cities by EPA found chloroform in every water system in levels ranging from <0.3 to 311 ppb.

**Incompatibilities:** Strong caustics, chemically active metals such as aluminum, magnesium powder, sodium, potassium.

**Permissible Exposure Limits in Air:** The Federal standard is 50 ppm (240  $\text{mg}/\text{m}^3$ ). The ACGIH recommended 1976 TLV was 25 ppm. NIOSH's recommended limit is a ceiling of 2 ppm based on a one-hour sample collected at 750  $\text{L}/\text{min}$ . ACGIH (1983/84) has set 10 ppm (50  $\text{mg}/\text{m}^3$ ) as a TWA with the notation that chloroform is an "Industrial Substance Suspect of Carcinogenic Potential for Man." The STEL value is 50 ppm (225  $\text{mg}/\text{m}^3$ ). The IDLH value is 1,000 ppm.

**Determination in Air:** Charcoal adsorption, workup with  $\text{CS}_2$ , analysis by gas chromatography. See NIOSH Methods, Set J. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life: 28,900  $\mu\text{g}/\text{L}$  on an acute basis and 1,240  $\mu\text{g}/\text{L}$  on a chronic basis. To protect saltwater aquatic life: no value set due to insufficient data. To protect human health: preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 1.9  $\mu\text{g}/\text{L}$ .

**Determination in Water:** Gas chromatography (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

**Routes of Entry:** Inhalation of vapors, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** *Local* – Chloroform may produce burns if left in contact with the skin.

*Systemic* – Chloroform is a relatively potent anesthetic at high concentrations. Death from its use as an anesthetic has resulted from liver damage and from cardiac arrest. Exposure may cause lassitude, digestive disturbance, dizziness, mental dullness, and coma. Chronic overexposure has been shown to cause enlargement of the liver and kidney damage. Alcoholics seem to be affected sooner and more severely from chloroform exposure. Disturbance of the liver is more characteristic of exposure than central nervous system depression or renal injury. There is animal experimental evidence that indicates chloroform is a carcinogen.

Chloroform was tested in three experiments in mice and in one in rats by oral administration. It produced hepatomas and hepatocellular carcinomas in mice, malignant kidney tumours in male rats and tumours of the thyroid in female rats. In another series of experiments in male mice chloroform administered orally produced benign and malignant kidney tumours (9).

**Points of Attack:** Liver, kidneys, heart, eyes, skin.

**Medical Surveillance:** Preplacement and periodic examinations should include appropriate tests for liver and kidney functions, and special attention should be given to the nervous system, the skin, and to any history of alcoholism. Expired air and blood levels may be useful in estimating levels of acute exposure.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent any reasonable probability of skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

#### Respirator Selection:

500 ppm: SA/SCBA  
1,000 ppm: SAF/SCBAF  
Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

Where possible it should be recovered, purified by distillation, and returned to the supplier.

#### References

- (1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Chloroform*, NIOSH Document No. 75-114, Washington, DC (1975).
- (2) National Institute for Occupational Safety and Health, *Current Intelligence Bulletin No. 9—Chloroform*, Washington, DC (1976).
- (3) U.S. Environmental Protection Agency, *Chloroform: Ambient Water Quality Criteria*, Washington, DC (1980).
- (4) National Academy of Sciences, *Chloroform, Carbon Tetrachloride and Other Halomethanes: An Environmental Assessment*, Washington, DC (1978).
- (5) U.S. Environmental Protection Agency, *Chloroform*, Health and Environmental Effects Profile No. 47, Office of Solid Waste, Washington, DC (April 30, 1980).
- (6) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, 20, 401, Lyon, France (1979).
- (7) See Reference (A-61).
- (8) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 44-47, New York, Van Nostrand Reinhold Co. (1981).
- (9) See Reference (A-62). Also see Reference (A-64).
- (10) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 5, 101-106, New York, Van Nostrand Reinhold Co. (1983).



- (11) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 1, pp 463-464, Geneva, International Labour Office (1983).
- (12) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. I, pp VII/185-88, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## CHLOROMETHYL METHYL ETHER

- Carcinogen (Suspected Human, IARC)(3)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:**  $\text{ClCH}_2\text{OCH}_3$ , chloromethyl methyl ether, is a volatile, corrosive liquid boiling at  $59^\circ\text{C}$ . Commercial chloromethyl methyl ether contains from 1 to 7% bis(chloromethyl) ether, a known carcinogen.

**Code Numbers:** CAS 107-30-2 RTECS KN6650000 UN 1239

**DOT Designation:** Flammable liquid and poison.

**Synonyms:** CMME, methyl chloromethyl ether, monochloromethyl ether, chloromethoxymethane.

**Potential Exposures:** Chloromethyl methyl ether is a highly reactive methylating agent and is used in the chemical industry for synthesis of organic chemicals. Most industrial operations are carried out in closed process vessels so that exposure is minimized.

**Permissible Exposure Limits in Air:** Chloromethyl methyl ether is included in the Federal standard for carcinogens; all contact with it should be avoided. ACGIH (1983/84) has designated it an "Industrial Substance Suspect of Carcinogenic Potential for Man."

**Determination in Air:** Collection by impinger, analysis by gas chromatography with electron capture detector (A-10).

**Permissible Concentration in Water:** No criteria have been set for the protection of freshwater or saltwater aquatic life due to lack of data. For the protection of human health: preferably zero.

**Routes of Entry:** Inhalation of vapor and possibly percutaneous absorption.

**Harmful Effects and Symptoms:** *Local* - Vapor exposure results in severe irritation of the skin, eyes and nose. Rabbit skin tests using undiluted material resulted in skin necrosis.

*Systemic* - Chloromethyl methyl ether is only moderately toxic given orally. Acute exposure to chloromethyl methyl ether vapor may result in pulmonary edema and pneumonia.

Several studies of workers with CMME manufacturing exposure have shown an excess of bronchiogenic cancer predominately of the small cell-undifferentiated type with relatively short latency period (typically 10 to 15 years). Therefore, commercial grade chloromethyl methyl ether must be considered a carcinogen (4). It is not known whether or not chloromethyl methyl ether's carcinogenic activity is due to bis(chloromethyl) ether (BCME) contamination, but this may be a moot question inasmuch as two of the hydrolysis products of CMME can combine to form BCME.

Animal experiments to determine chloromethyl methyl ether's ability to produce skin cancer indicated marginal carcinogenic activity; highly pure CMME

was used. Inhalation studies, using technical grade CMME showed only one bronchiogenic cancer and one esthesioneuroepithelioma out of 79 animals exposed.

**Medical Surveillance:** Preplacement and periodic medical examinations should include an examination of the skin and respiratory tract, including a chest x-ray. Sputum cytology has been suggested as helpful in detecting early malignant changes, and in this connection a detailed smoking history is of importance. Possible effects on the fetus should be considered.

**Personal Protective Methods:** These are designed to supplement engineering controls and to prevent all skin or respiratory contact. Full body protective clothing and gloves should be used on entering areas of partial exposure. Those employed in handling operations should be provided with fullface, supplied-air respirators of continuous-flow or pressure-demand type. On exit from a regulated area, employees should be required to remove and leave protective clothing and equipment at the point of exit, to be placed in impervious containers at the end of the workshift for decontamination or disposal. Showers should be taken prior to dressing in street clothes.

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

### References

- (1) U.S. Environmental Protection Agency, *Chloroalkyl Ethers: Ambient Water Quality Criteria*, Washington, DC (1980).
- (2) U.S. Environmental Protection Agency, *Chloroalkyl Ethers*, Health and Environmental Effects Profile No. 41, Office of Solid Waste, Washington, DC (April 30, 1980).
- (3) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, 4, 239, Lyon, France (1974).
- (4) See Reference (A-62). Also see Reference (A-64).
- (5) See Reference (A-60).
- (6) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. I, pp VII/345-46, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## 2-CHLORONAPHTHALENE

See "Chlorinated Naphthalenes."

## CHLORONITROBENZENES

See o-Nitrochlorobenzene and p-Nitrochlorobenzene entries in this volume.

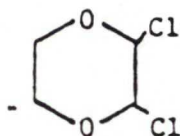
## 1-CHLORO-1-NITROPROPANE

**Description:**  $\text{C}_2\text{H}_5\text{CHClNO}_2$  is a colorless liquid with an unpleasant odor that causes tears (lachrymator). It boils at  $171^\circ\text{C}$ .

**Code Numbers:** CAS 600-25-9 RTECS TX5075000



**Description:**  $C_4H_6Cl_2O_2$  has the following structural formula



This is a colorless liquid boiling at 88° to 89°C at 19 mm Hg pressure.

**Code Numbers:** CAS 95-59-0. Transisomer: CAS 3883-43-0

RTECS JG9800000

**DOT Designation:** —

**Potential Exposure:** Used in the manufacture of the pesticide, dioxathion.

**Permissible Exposure Limits in Air:** No limits set.

**Permissible Concentration in Water:** No criteria set.

**Routes of Entry:** Inhalation and skin absorption.

**Harmful Effects and Symptoms:** The oral LD-50 for rats is about 2,000 mg/kg which is only in the "slightly toxic" range. However, carcinogenicity has been demonstrated in mice and rats and is suspected in humans by analogy with other chloroethers (1).

#### References

- (1) U.S. Environmental Protection Agency, *Chemical Hazard Information Profile Draft Report: 2,3-Dichloro-1,4-Dioxane*, Washington, DC (August 29, 1983).

## X 1,1-DICHLOROETHANE

- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:**  $CH_3CHCl_2$  is a colorless liquid with a chloroform-like odor boiling at 57.3°C.

**Code Numbers:** CAS 75-34-3 RTECS KI0175000 UN 2362

**DOT Designation:** Flammable liquid.

**Synonyms:** Asymmetrical dichloroethane; ethylidene chloride; 1,1-ethylidene dichloride.

**Potential Exposure:** NIOSH has estimated the number of workers exposed at 4,600. It is used as a solvent and cleaning and degreasing agent as well as in organic synthesis as an intermediate.

**Incompatibilities:** Strong oxidizers, strong caustics.

**Permissible Exposure Limits in Air:** The Federal limit is 100 ppm (400 mg/m<sup>3</sup>). The ACGIH TWA value as of 1983/84 is 200 ppm (810 mg/m<sup>3</sup>) and the STEL value is 250 ppm (1,010 mg/m<sup>3</sup>). The IDLH level is 4,000 ppm.

**Determination in Air:** Charcoal adsorption, workup with  $CS_2$ , analysis by gas chromatography. See NIOSH Methods, Set I. See also reference (A-10).

**Permissible Concentration in Water:** No criteria set for aquatic life or human health due to insufficient data.

**Determination in Water:** Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

**Routes of Entry:** Inhalation, ingestion, eye and skin contact.

**Harmful Effects and Symptoms:** Central nervous system depression; skin irritation; drowsiness; unconsciousness; liver and kidney damage.

**Points of Attack:** Skin, liver, kidneys.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, flush with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water to induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

#### Respirator Selection:

- 1,000 ppm: CCROV/SA/SCBA
- 4,000 ppm: GMOV/SAF/SAF:PD,PP,CF/SCBAF
- Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration; preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

#### References

- (1) U.S. Environmental Protection Agency, *Chloroethanes: Ambient Water Quality Criteria*, Washington, DC (1980).
- (2) U.S. Environmental Protection Agency, *1,1-Dichloroethane*, Health and Environmental Effects Profile No. 69, Washington, DC, Office of Solid Waste (April 30, 1980).
- (3) See Reference (A-61).
- (4) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 44-47, New York, Van Nostrand Reinhold Co. (1984).

## 1,2-DICHLOROETHANE

See "Ethylene Dichloride."

## 1,2-DICHLOROETHYLENE

- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)



**Description:**  $\text{ClCH=CHCl}$ , 1,2-dichloroethylene, exists in two isomers, cis 60% and trans 40%. There are variations in toxicity between these two forms. At room temperature, it is a liquid with a slight acrid, ethereal odor. Gradual decomposition results in hydrochloric acid formation in the presence of ultraviolet light or upon contact with hot metal.

**Code Numbers:** CAS 540-59-0 RTECS KV9360000 UN 1150

**DOT Designation:** Flammable liquid.

**Synonyms:** Acetylene dichloride, sym-dichloroethylene, 1,2-dichloroethylene.

**Potential Exposure:** 1,2-Dichloroethylene is used as a solvent for waxes, resins, and acetylcellulose. It is also used in the extraction of rubber, as a refrigerant, in the manufacture of pharmaceuticals and artificial pearls, and in the extraction of oils and fats from fish and meat.

**Incompatibilities:** Strong oxidizers.

**Permissible Exposure Limits in Air:** Federal standard is 200 ppm (790 mg/m<sup>3</sup>). The ACGIH (1983/1984) STEL value is 250 ppm (1,000 mg/m<sup>3</sup>). The IDLH level is 4,000 ppm.

**Determination in Air:** Charcoal adsorption, workup with CS<sub>2</sub>, analysis by gas chromatography. See NIOSH Method, Set H. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life—11,600 µg/l on an acute toxicity basis for dichloroethylenes in general. To protect saltwater aquatic life: 224,000 µg/l on an acute toxicity basis for dichloroethylenes as a class. To protect human health—no criteria developed due to insufficient data.

**Determination in Water:** Trans-1,2-dichloroethylene may be determined by inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

**Routes of Entry:** Inhalation of the vapor, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** *Local* — This liquid can act as a primary irritant producing dermatitis and irritation of mucous membranes.

*Systemic* — 1,2-Dichloroethylene acts principally as a narcotic, causing central nervous system depression. Symptoms of acute exposure include dizziness, nausea and frequent vomiting, and central nervous system intoxication similar to that caused by alcohol. Renal effects, when they do occur, are transient.

**Points of Attack:** Respiratory system, eyes, central nervous system.

**Medical Surveillance:** Consider possible irritant effects on skin or respiratory tract as well as liver and renal function in preplacement or periodic examinations. Expired air analyses may be useful in detecting exposure.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable prob-

ability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove clothing promptly if wet or contaminated to avoid flammability hazard.

#### Respirator Selection:

- 1,000 ppm: CCROVF
- 4,000 ppm: GMOV/SAF/SCBAF
- Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

#### References

- (1) U.S. Environmental Protection Agency, *Dichloroethylenes: Ambient Water Quality Criteria*, Washington, DC (1980).
- (2) U.S. Environmental Protection Agency, *Trans-1,2-Dichloroethylene*, Health and Environmental Effects Profile No. 72, Washington, DC, Office of Solid Waste (April 30, 1980).
- (3) U.S. Environmental Protection Agency, *Dichloroethylenes*, Health and Environmental Effects Profile No. 73, Washington, DC, Office of Solid Waste (April 30, 1980).
- (4) See Reference (A-61).
- (5) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 48-53, New York, Van Nostrand Reinhold Co. (1984).

## DICHLOROETHYL ETHER

- Carcinogen (Animal positive, IARC) (3)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:**  $\text{ClCH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{Cl}$  is a clear, colorless liquid with a pungent, fruity odor. It is also described as having a chlorinated solvent-like odor. It boils at 176° to 178°C.

**Code Numbers:** CAS 111-44-4 RTECS KN0875000 UN 1916

**DOT Designation:** Flammable liquid, poison.

**Synonyms:** Dichloroether, dichloroethyl oxide, sym-dichloroethyl ether, bis(2-chloroethyl) ether, 2,2'-dichloroethyl ether, BCEE, Chlorex®.

**Potential Exposure:** Dichloroethyl ether is used in the manufacture of paint, varnish, lacquer, soap, and finish remover. It is also used as a solvent for cellulose esters, naphthalenes, oils, fats, greases, pectin, tar, and gum; in dry cleaning; in textile scouring; and in soil fumigation.

**Incompatibilities:** Strong oxidizers.

**Permissible Exposure Limits in Air:** The Federal standard for dichloroethyl ether is 15 ppm (90 mg/m<sup>3</sup>); however, the ACGIH recommended TLV as of 1983/84 is 5 ppm (30 mg/m<sup>3</sup>). ACGIH adds the notation "skin" indicating the possibility of cutaneous absorption. The STEL value is 10 ppm (60 mg/m<sup>3</sup>). The IDLH level is 250 ppm.

**Determination in Air:** Charcoal adsorption, workup with CS<sub>2</sub>, analysis by gas chromatography. See NIOSH Methods, Set V. See also reference (A-10).



- (2) National Institute for Occupational Safety and Health, *Information Profiles on Potential Occupational Hazards—Single Chemicals: N,N-Dimethyl Formamide*, 65-73, Report TR79-607, Rockville, MD (December 1979).
- (3) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 61-62, New York, Van Nostrand Reinhold Co. (1981).
- (4) See Reference (A-61).
- (5) See Reference (A-60).

## 1,1-DIMETHYLHYDRAZINE

- Carcinogen (Animal positive, IARC) (2)
- Hazardous waste (EPA)

**Description:**  $(\text{CH}_3)_2\text{NNH}_2$  is a fuming colorless liquid with an amine-like odor. It boils at 63°C.

**Code Numbers:** CAS 57-14-7 RTECS MV2450000 UN 1163

**DOT Designation:** Flammable liquid and poison.

**Synonyms:** Unsymmetrical dimethylhydrazine, UDMH; Dimazine®.

**Potential Exposure:** This material is used as a component in liquid rocket propellant combinations; it is also used as an intermediate in organic synthesis.

**Incompatibilities:** Oxidizers, halogens, metallic mercury, fuming nitric acid, hydrogen peroxide.

**Permissible Exposure Limits in Air:** The Federal limit is 0.5 ppm (1 mg/m<sup>3</sup>). The notation "skin" indicates the possibility of cutaneous absorption. The ACGIH has set an STEL of 1.0 ppm (2 mg/m<sup>3</sup>) with the notation that UMDH is an "industrial substance suspect of carcinogenic potential for man." NIOSH (1) has proposed a 2-hr ceiling concentration of 0.06 ppm (0.15 mg/m<sup>3</sup>). The IDLH level is 50 ppm.

**Determination in Air:** Collection by a bubbler, colorimetric determination with phosphomolybdic acid. See NIOSH Methods, Set K. See also reference (A-10).

**Permissible Concentration in Water:** No criteria set, but EPA (A-37) has suggested a permissible ambient goal of 13.8 µg/l based on health effects.

**Routes of Entry:** Inhalation, skin absorption, ingestion, eye and skin contact.

**Harmful Effects and Symptoms:** Eye irritation; choking, chest pains, dyspnea; lethargy; nausea; skin irritation; anoxia; convulsions; liver injury.

**Points of Attack:** Central nervous system, liver, gastrointestinal system, blood, respiratory system, eyes, skin.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, flush with water immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent any possibility of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide emergency showers and eyewash.

### Respirator Selection:

25 ppm: SAF/SCBAF  
50 ppm: SAF:PD,PP,CF  
Escape: GMSF/SCBAF

**Disposal Method Suggested:** Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

### References

- (1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Hydrazines*, NIOSH Doc. No. 78-172, Washington, DC (1978).
- (2) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France 4, 137 (1974).
- (3) See Reference (A-60).
- (4) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 60-67, New York, Van Nostrand Reinhold Co. (1984).

## DIMETHYL METHYLPHOSPHONATE

**Description:**  $(\text{CH}_3\text{O})_2\overset{\text{O}}{\parallel}\text{PCH}_3$  is a colorless liquid which boils at 180°C at 760 mm pressure.

**Code Numbers:** CAS 756-79-6 RTECS SZ912000

**DOT Designation:** —

**Synonyms:** Phosphonic acid, methyl-, dimethyl ester; DMMP.

**Potential Exposure:** May be used as a gasoline additive, hydraulic fluid additive, as a heavy metal extractor, as a solvent, as a simulant for nerve gas agents, and as an additive flame retardant in plastics.

**Permissible Exposure Limits in Air:** No standards set.

**Permissible Concentration in Water:** No criteria set.

**Harmful Effects and Symptoms:** DMMP is not very toxic; the oral LD-50 in mice and rats is greater than 5,000 mg/kg. There are some indications of alteration in reproductive functions of rats exposed to doses of 250 mg/kg, however.

### References

- (1) U.S. Environmental Protection Agency, *Chemical Hazard Information Profile Draft Report: Dimethyl methylphosphonate*, Washington, DC (September 2, 1983).

## 2,4-DIMETHYLPHENOL

- Hazardous substance (EPA)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)



**Description:**  $C_8H_{10}O$ ,  $HOC_6H_3(CH_3)_2$ , is a colorless crystalline solid melting at 27° to 28°C. The 2,4-isomer is one of 5 isomers of this formula.

**Code Numbers:** CAS 105-67-9 RTECS ZE5600000

**DOT Designation:** —

**Synonyms:** 2,4-Xylenol; 1-hydroxy-2,4-dimethylbenzene; m-xylenol; 2,4-DMP.

**Potential Exposure:** 2,4-DMP finds use commercially as an important chemical feedstock or constituent for the manufacture of a wide range of commercial products for industry and agriculture. 2,4-Dimethylphenol is used in the manufacture of phenolic antioxidants, disinfectants, solvents, pharmaceuticals, insecticides, fungicides, plasticizers, rubber chemicals, polyphenylene oxide, wetting agents, and dyestuffs, and is an additive or constituent of lubricants, gasolines, and cresylic acid. 2,4-Dimethylphenol (2,4-DMP) is a naturally occurring, substituted phenol derived from the cresol fraction of petroleum or coal tars by fractional distillation and extraction with aqueous alkaline solutions. It is the cresylic acid or tar acid fraction of coal tar.

Workers involved in the fractionation and distillation of petroleum or coal and coal tar products comprise one group at risk. Workers who are intermittently exposed to certain commercial degreasing agents containing cresol may also be at risk. Cigarette and marijuana smoking groups and those exposed to cigarette smoke inhale  $\mu g$  quantities of 2,4-dimethylphenol. The National Institute for Occupational Safety and Health has estimated that 11,000 people in the United States are occupationally exposed to cresol containing 2,4-dimethylphenol.

**Permissible Exposure Limits in Air:** No standards set.

**Permissible Concentration in Water:** To protect freshwater aquatic life—2,120  $\mu g/l$  on an acute toxicity basis. To protect saltwater aquatic life—no criterion established due to insufficient data. To protect human health—in view of the relative paucity of data on the mutagenicity, carcinogenicity, teratogenicity and long term oral toxicity of 2,4-dimethylphenol, estimates of the effects of chronic oral exposure at low levels cannot be made with any confidence. It is recommended that studies to produce such information be conducted before limits in drinking water are established. A criterion of 400  $\mu g/l$  is suggested by EPA (1) on an organoleptic basis.

**Determination in Water:** Methyl chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

**Harmful Effects and Symptoms:** 2,4-Dimethylphenol appears to be a topical cocarcinogen, but its role as a primary cancer-producing agent is uncertain. Its potential role in cancer production warrants consideration of further testing. An in vitro mutagenicity assay should be carried out to further evaluate its mutagenic potential.

**Disposal Method Suggested:** Incineration.

#### Reference

- (1) U.S. Environmental Protection Agency, *2,4-Dimethylphenol: Ambient Water Quality Criteria*, Washington, DC (1980).
- (2) U.S. Environmental Protection Agency, *2,4-Dimethylphenol*, Health and Environmental Effects Profile No. 87, Washington, DC, Office of Solid Waste (April 30, 1980).

## DIMETHYL PHTHALATE

- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:**  $C_6H_4(COOCH_3)_2$  is a colorless oily liquid with a slight ester odor. It boils at 285°C.

**Code Numbers:** CAS 131-11-3 RTECS T11575000

**DOT Designation:** —

**Synonyms:** Phthalic acid, dimethyl ester; dimethyl 1,2-benzenedicarboxylate; DMP; ENT-262.

**Potential Exposure:** Dimethyl phthalate is used as a plasticizer for cellulose ester plastics and as an insect repellent (3).

**Incompatibilities:** Nitrates, strong oxidizers, strong alkalies, strong acids.

**Permissible Exposure Limits in Air:** The Federal limit and the TWA value adopted by ACGIH (1983/84) is 5  $mg/m^3$ . The STEL value is 10  $mg/m^3$ . The IDLH level is 9,300  $mg/m^3$ .

**Determination in Air:** Collection by charcoal tube, analysis by gas liquid chromatography (A-13).

**Permissible Concentration in Water:** To protect freshwater and saltwater aquatic life—no criteria developed due to insufficient data. To protect human health—313  $mg/l$ .

**Determination in Water:** Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 606) or gas chromatography plus mass spectrometry (EPA Method 626).

**Routes of Entry:** Ingestion, inhalation, eye and skin contact.

**Harmful Effects and Symptoms:** Irritation of nasal passages and upper respiratory system; stomach irritation; eye pain.

**Points of Attack:** Respiratory system, gastrointestinal (GI) system.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**First Aid:** If this chemical gets into the eyes, irrigate promptly. If this chemical contacts the skin, wash regularly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear eye protection to prevent any reasonable probability of eye contact.

**Respirator Selection:**

250  $mg/m^3$ : HiEPF/SAF/SCBAF  
9,300  $mg/m^3$ : SAF,PD,PP,CF

**Disposal Method Suggested:** Incineration.

#### References

- (1) U.S. Environmental Protection Agency, *Phthalate Esters: Ambient Water Quality Criteria*, Washington, DC (1980).



## PHENOL

- Hazardous substance (EPA)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:**  $C_6H_5OH$ , phenol, is a white crystalline substance with a distinct aromatic, acid odor. It melts at  $41^\circ C$ .

**Code Numbers:**

CAS 108-95-2

RTECS SJ3325000

UN 1671 (Solid)

UN 2312 (Molten)

**DOT Designation:** Poison B.

**Synonyms:** Carboic acid, phenic acid, phenylic acid, phenyl hydrate, hydroxybenzene, monohydroxybenzene.

**Potential Exposures:** Phenol is used in the production or manufacture of explosives, fertilizer, coke, illuminating gas, lampblack, paints, paint removers, rubber, asbestos goods, wood preservatives, synthetic resins, textiles, drugs, pharmaceutical preparations, perfumes, bakelite, and other plastics (phenol-formaldehyde resins) as well as polymer intermediates (caprolactam, bisphenol-A and adipic acid). Phenol also finds wide use as a disinfectant in the petroleum, leather, paper, soap, toy, tanning, dye, and agricultural industries. NIOSH estimates that 10,000 employees are potentially exposed to phenol in the United States. This reflects the number of people that are employed in the production of phenol, formulation into products, or distribution of concentrated products. In addition, an uncertain but probably large number of people will have intermittent contact with phenol as components of medications or in the workplace as chemists, pharmacists, biomedical personnel, and other occupations.

**Incompatibilities:** Strong oxidizers, calcium hypochlorite.

**Permissible Exposure Limits in Air:** The Federal standard and the ACGIH 1983/84 TWA value is 5 ppm ( $19 \text{ mg/m}^3$ ). NIOSH recommends (1) that exposure to phenol vapor, solid, or mists be limited to no more than  $20 \text{ mg/m}^3$  expressed as a time-weighted average (TWA) concentration for up to a 10-hour workshift, 40-hour workweek. In addition, to protect employees from peak overexposures, NIOSH recommends that exposures be limited to no more than  $60 \text{ mg/m}^3$  for any 15-minute period. There is thus no substantial change in the present Federal limit of  $19 \text{ mg/m}^3$  (5 ppm), except for the inclusion of a ceiling value. The STEL value is 10 ppm ( $38 \text{ mg/m}^3$ ). The IDLH level is 100 ppm. ACGIH adds the notation "skin" to indicate the possibility of cutaneous absorption.

**Determination in Air:** Collection in a bubbler using NaOH, workup with  $H_2SO_4$ , analysis by gas chromatography. See NIOSH Methods, Set L. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life— $10,200 \text{ } \mu\text{g/l}$ , based on acute toxicity data and  $2,560 \text{ } \mu\text{g/l}$ , based on chronic toxicity data. To protect saltwater aquatic life— $5,800 \text{ } \mu\text{g/l}$ , based on acute toxicity data. For the protection of human health from phenol ingested through water and through contaminated aquatic organisms the concentration in water should not exceed  $3,500 \text{ } \mu\text{g/l}$ . For the prevention of adverse effects due to the organoleptic properties of chlorinated phenols inadvertently formed during water purification processes, the phenol concentration in water should not exceed  $300 \text{ } \mu\text{g/l}$ .

**Determination in Water:** Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

**Routes of Entry:** Inhalation of mist or vapor; percutaneous absorption of mist, vapor, or liquid, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** *Local* — Phenol has a marked corrosive effect on any tissue. When it comes in contact with the eyes it may cause severe damage and blindness. On contact with the skin, it does not cause pain but causes a whitening of the exposed area. If the chemical is not removed promptly, it may cause a severe burn or systemic poisoning.

*Systemic* — Systemic effects may occur from any route of exposure. These include paleness, weakness, sweating, headache, ringing of the ears, shock, cyanosis, excitement, frothing of the nose and mouth, dark colored urine, and death. If death does not occur, kidney damage may occur.

Repeated or prolonged exposure to phenol may cause chronic phenol poisoning. This condition is very rarely reported. The symptoms of chronic poisoning include vomiting, difficulty in swallowing, diarrhea, lack of appetite, headache, fainting, dizziness, dark urine, mental disturbances, and possibly, skin rash. Liver and kidney damage and discoloration of the skin may occur.

**Points of Attack:** Liver, kidney, skin.

**Medical Surveillance:** Consider the skin, eye, liver, and renal function as part of any preplacement or periodic examination. Phenol can be determined in blood or urine.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** In areas where there is likelihood of a liquid spill or splash, impervious protective clothing and goggles should be worn. In areas of heavy vapor concentration, fullface mask with forced air supply should be used, as well as protective clothing, gloves rubber boots, and apron. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

**Respirator Selection:**

50 ppm: CCROVDM/SA/SCBA

100 ppm: CCROVDM/GMOVDM/SAF/SCBAF

Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration.

**References**

- (1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Phenol*, NIOSH Doc. No. 76-196 (1976).
- (2) U.S. Environmental Protection Agency, *Phenol: Ambient Water Quality Criteria*, Washington, DC (1980).
- (3) U.S. Environmental Protection Agency, *Phenol*, Health and Environmental Effects Profile No. 144, Office of Solid Waste, Washington, DC (April 30, 1980).



- (4) See Reference (A-61).
- (5) See Reference (A-60).
- (6) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 77-84, New York, Van Nostrand Reinhold Co. (1983).
- (7) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 1671-76, Geneva, International Labour Office (1983) (Phenols & Phenolic Compounds).
- (8) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. II, pp VII/496-501, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## PHENOTHIAZINE

**Description:**  $C_{12}H_9NS$ ,  $S(C_6H_4)_2NH$ , is a greenish-yellow to greenish-gray crystalline substance which melts at 175° to 185°C.

**Code Numbers:** CAS 92-84-2 RTECS SN5075000

**DOT Designation:** —

**Synonyms:** Thiodiphenylamine, dibenzothiazine.

**Potential Exposures:** Phenothiazine is used as an anthelmintic in medicine and veterinary medicine; it is used widely as an intermediate in pharmaceutical manufacture (A-41).

**Permissible Exposure Limits in Air:** There is no Federal standard but ACGIH (1983/84) has adopted a TWA value of 5 mg/m<sup>3</sup> with the notation "skin" indicating the possibility of cutaneous absorption. The STEL value is 10 mg/m<sup>3</sup>.

**Permissible Concentration in Water:** No criteria set.

**Routes of Entry:** Skin absorption, ingestion, inhalation, skin and eye contact.

**Harmful Effects and Symptoms:** Tonic hepatitis, hemolytic anemia, abdominal cramps and tachycardia, gastrointestinal and skin irritation, kidney damage, skin photosensitization and pruritis, hair and fingernail coloration (reddish-brown), conjunctivitis and keratitis.

**Points of Attack:** Skin, eyes, gastrointestinal system, liver, kidney, blood.

**Medical Surveillance:** Observe points of attack in preplacement and regular physical examinations.

**First Aid:** Flush eyes with water, wash contaminated body areas with soap and water. Flush stomach with water if swallowed (A-38).

**Personal Protective Methods:** Wear butyl rubber gloves, full protective clothing and protective shoes.

**Respirator Selection:** Wear self-contained breathing apparatus (A-38).

**Disposal Method Suggested:** Dissolve in combustible solvent and spray into incinerator equipped with afterburner and scrubber.

### References

- (1) See Reference (A-60).
- (2) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 1676-77, Geneva, International Labour Office (1983).

## p-PHENYLENEDIAMINE

**Description:**  $H_2NC_6H_4NH_2$  is a white to light purple or brown solid which melts at 141°C.

**Code Numbers:** CAS 106-50-3 RTECS SS8050000 UN 1673

**DOT Designation:** ORM-A.

**Synonyms:** p-Aminoaniline, 1,4-diaminobenzene, benzenediamine, PARA.

**Potential Exposure:** p-Phenylenediamine has been used in fur dyes and as a monomer in the manufacture of improved tire cords.

**Incompatibilities:** Strong oxidizers.

**Permissible Exposure Limits in Air:** The Federal standard and the 1983/84 ACGIH TWA value is 0.1 mg/m<sup>3</sup>. The notation "skin" is added to indicate the possibility of cutaneous absorption. There is no STEL value set. The IDLH level is 25 mg/m<sup>3</sup>.

**Determination in Air:** Collection by impinger or fritted bubbler, colorimetric analysis (A-26).

**Permissible Concentration in Water:** No criteria set.

**Routes of Entry:** Inhalation, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** Irritation of pharynx and larynx, bronchial asthma, sensitization to dermatitis.

**Points of Attack:** Respiratory system, skin.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent any reasonable probability of skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated and daily at the end of each work shift. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

### Respirator Selection:

5 mg/m<sup>3</sup>: SAF/SCBAF

25 mg/m<sup>3</sup>: SAF:PD,PP,CF

Escape: GMS/SCBA

**Disposal Method Suggested:** Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.

### References

- (1) U.S. Environmental Protection Agency, *Chemical Hazard Information Profile: Phenylenediamines*, Washington, DC (June 1, 1978).
- (2) See Reference (A-61).



flame retardants (Firemaster BP-6) has stimulated extensive studies of the potential for water contamination, transport, bioaccumulation, biological and toxicological nature of this class of environmental agent (1).

Cows from the herds in Michigan which were fed PBB-contaminated feed exhibited essentially the same symptoms as cattle tested in the laboratory. These symptoms included anorexia and weight loss, abnormal hoof growth, reduced milk production, and hepatomas; pregnant cows often delivered late by 2 to 4 weeks, with many calves stillborn or dead shortly after birth (3). The PBB composition involved was composed of 60 to 70% of 2,4,5,2',4',5'-hexabromobiphenyl, with the remainder consisting of lesser amounts of tetra-, penta-, and heptahomologs in addition to various brominated naphthalenes. It has not yet been determined which of the constituents was responsible for the toxic action that was observed.

While no immediate adverse health effects were noted in several thousand Michigan farm families which consumed milk and dairy products contaminated with PBBs, it is not possible to determine at this date any chronic or delayed effects that might be attributed to the PBBs or the potential ability of this chemical to cause birth defects.

The toxic activity of PBBs is exerted primarily on the liver and kidneys, marked by hyperplasia and necrosis. Affected to a lesser extent are the thyroid, uterus, skin, gall bladder, gastrointestinal tract, myocardium and endocardium, and body tissues, especially fatty tissues.

Firemaster FF-1 (Firemaster BP-6 containing 2% of calcium trisilicate)—a mixture of pentabromobiphenyl, hexabromobiphenyl and heptabromobiphenyl with hexabromobiphenyl being the major component—administered by gavage produced neoplastic nodules and hepatocellular carcinomas in female Sherman strain rats (4). In another bioassay, Firemaster FF-1, also administered by gavage, was carcinogenic to Fischer 344 rats and B6C3F1 mice of each sex, inducing neoplastic nodules, hepatocellular carcinomas, and cholangiocarcinomas in rats and hepatocellular carcinomas in mice (5).

**Points of Attack:** Liver, kidneys, skin (3).

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**Disposal Method Suggested:** See "Polychlorinated Biphenyls" (entry which follows) for techniques which may be applicable.

#### References

- (1) U.S. Environmental Protection Agency, *Summary Characterization of Selected Chemicals of Near-Term Interest*, Report EPA-560/4-76-004, Washington, DC (April 1976).
- (2) U.S. Environmental Protection Agency, *Status Assessment of Toxic Chemicals: Polybrominated Biphenyls*, Report EPA-600/2-79-210k, Washington, DC (December 1979).
- (3) Nat. Inst. for Occup. Safety and Health, *Information Profiles on Potential Occupational Hazards*, Report PB-276,678, Rockville, MD, pp 76-85 (October 1977).
- (4) Kimbrough, R.D., D.F. Groce, M.P. Korver, and V.W. Burse, *Induction of Liver Tumors in Female Sherman Strain Rats by Polybrominated Biphenyls*, J. Nat. Cancer Inst., Vol. 66, No. 3, pp 535-542 (1981).
- (5) National Toxicology Program, *NTP Technical Report on the Toxicology and Carcinogenesis Bioassay of Polybrominated Biphenyl Mixture (Firemaster FF-1)*, Technical Report Series No. 244, NIH Publication No. 82-1800, Research Triangle Park, North Carolina (1982).
- (6) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. II, pp VII/371, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## POLYCHLORINATED BIPHENYLS (PCBs)

- Carcinogens (Animal positive, IARC) (4)
- Hazardous materials (EPA)
- Hazardous waste constituents (EPA)
- Priority toxic pollutants (EPA)

**Description:**  $C_{12}H_{10-x}Cl_x$ , diphenyl rings in which one or more hydrogen atoms are replaced by a chlorine atom. Most widely used are chlorodiphenyl (42% chlorine), containing 3 chlorine atoms in unassigned positions, and chlorodiphenyl (54% chlorine) containing 5 chlorine atoms in unassigned positions. These compounds are light, straw-colored liquids with typical chlorinated aromatic odors; 42% chlorodiphenyl is a mobile liquid and 54% chlorodiphenyl is a viscous liquid.

Polychlorinated biphenyls are prepared by the chlorination of biphenyl and hence are complex mixtures containing isomers of chlorobiphenyls with different chlorine contents. It should be noted that there are 209 possible compounds obtainable by substituting chlorine for hydrogen on from one to ten different positions on the biphenyl ring system. An estimated 40 to 70 different chlorinated biphenyl compounds can be present in each of the higher chlorinated commercial mixtures. For example, Aroclor 1254 contains 69 different molecules, which differ in the number and position of chlorine atoms.

It should also be noted that certain PCB commercial mixtures produced in the United States and elsewhere (e.g., France, Germany, and Japan) have been shown to contain other classes of chlorinated derivatives, e.g., chlorinated naphthalenes and chlorinated dibenzofurans. The possibility that naphthalene and dibenzofuran contaminate the technical biphenyl feedstock used in the preparation of the commercial PCB mixtures cannot be excluded.

**Code Numbers:** CAS 1336-36-3 RTECS TQ1350000 UN 2315

**DOT Designation:** ORM-E.

**Synonyms:** PCBs, chlorodiphenyls, Aroclors®, Kanechlors®.

**Potential Exposures:** Chlorinated diphenyls are used alone and in combination with chlorinated naphthalenes. They are stable, thermoplastic, and non-flammable, and find chief use in insulation for electric cables and wires in the production of electric condensers, as additives for extreme pressure lubricants, and as a coating in foundry use.

Polychlorinated biphenyls (PCBs, first introduced into commercial use more than 45 years ago) are one member of a class of chlorinated aromatic organic compounds which are of increasing concern because of their apparent ubiquitous dispersal, persistence in the environment, and tendency to accumulate in food chains, with possible adverse effects on animals at the top of food webs, including man.

**Incompatibilities:** Strong oxidizers.

**Permissible Exposure Limits in Air:** The Federal standards and 1983/84 ACGIH TWA values for chlorodiphenyl (42% Cl) and chlorodiphenyl (54% Cl) are 1 mg/m<sup>3</sup> and 0.5 mg/m<sup>3</sup>, respectively. NIOSH has recommended a level of 1.0 µg/m<sup>3</sup> on a 10-hour TWA basis for both compounds. The STEL values adopted by ACGIH are 2 mg/m<sup>3</sup> and 1.0 mg/m<sup>3</sup>, respectively. The ID<sub>1</sub>H levels are 10 mg/m<sup>3</sup> and 5 mg/m<sup>3</sup>, respectively.

**Determination in Air:** For the 42% Cl compound, use of a filter plus bubbler



followed by gas chromatography. See NIOSH Methods, Set 2. For the 54% Cl compound, use of a filter, workup with petroleum ether, analysis by gas chromatography. See NIOSH Methods, Set 1. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life—0.014 µg/l as a 24-hour average. To protect saltwater aquatic life—0.030 µg/l as a 24-hour average. To protect human health—preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 0.00079 µg/l.

**Determination in Water:** Gas chromatography (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625).

**Routes of Entry:** Inhalation of fume or vapor and percutaneous absorption of liquid, ingestion, eye and skin contact.

**Harmful Effects and Symptoms:** *Local* — Prolonged skin contact may cause the formation of comedones, sebaceous cysts, and pustules, known as chloracne. Irritation of eyes, nose, and throat may also occur. The above standards are considered low enough to prevent systemic effects, but it is not known whether or not these levels will prevent local effects.

*Systemic* — Generally, toxic effects are dependent upon the degree of chlorination; the higher the degree of substitution, the stronger the effects. Acute and chronic exposure can cause liver damage. Signs and symptoms include edema, jaundice, vomiting, anorexia, nausea, abdominal pains, and fatigue.

Studies of accidental oral intake indicate that chlorinated diphenyls are embryotoxic, causing stillbirth, a characteristic grey-brown skin, and increased eye discharge in infants born to women exposed during pregnancy.

Certain polychlorinated biphenyls are carcinogenic in mice and rats after oral administration, producing liver tumors (4).

A slight increase in the incidence of cancer, particularly melanoma of the skin, has been reported in a small group of men exposed occupationally to Arochlor 1254, a mixture of polychlorinated biphenyls (4,7).

**Points of Attack:** Skin, eyes, liver.

**Medical Surveillance:** Placement and periodic examinations should include an evaluation of the skin, lung, and liver function. Possible effects on the fetus should be considered.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of saltwater and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent any possibility of skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

#### Respirator Selection:

42% Cl compound, 10 mg/m<sup>3</sup>: SAF/SCBAF  
Escape: GMPest/SCBA  
54% Cl compound, 5 mg/m<sup>3</sup>: SAF/SCBAF  
Escape: GMPest/SCBA

**Disposal Method Suggested:** Incineration (3000°F) with scrubbing to remove any chlorine-containing products (A-31). In addition, some chemical waste

landfills have been approved for PCB disposal. More recently treatment with metallic sodium has been advocated which yields a low molecular weight polyphenylene and sodium chloride.

#### References

- (1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Polychlorinated Biphenyls*, NIOSH Doc. No. 77-225 (1977).
- (2) U.S. Environmental Protection Agency, *Polychlorinated Biphenyls: Ambient Water Quality Criteria*, Washington, DC (1980).
- (3) National Academy of Sciences, *Polychlorinated Biphenyls*, Washington, DC (1979).
- (4) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France, 7, 261 (1974) and 18, 43 (1978).
- (5) World Health Organization, *Polychlorinated Biphenyls and Triphenyls*, Environmental Health Criteria No. 2, Geneva, Switzerland (1976).
- (6) See Reference (A-62). Also see Reference (A-64).
- (7) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Supplement 1, Lyon, France, p 41 (1979).
- (8) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 95-100, New York, Van Nostrand Reinhold Co. (1983).
- (9) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 1753-55, Geneva, International Labour Office (1983).
- (10) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. II, pp VII/644-60, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## POLYNUCLEAR AROMATIC HYDROCARBONS

- Carcinogen (Benzo[a]pyrene) (Animal positive, IARC) (8)
- Hazardous wastes (EPA)
- Priority toxic pollutants (EPA)

**Description:** The polynuclear aromatic hydrocarbons constitute a class of materials of which benzo[a]pyrene is one of the most common and also the most hazardous.

Benzo[a]pyrene, C<sub>20</sub>H<sub>12</sub>, is a yellowish crystalline solid, melting at 179°C. It consists of five benzene rings joined together. Other polynuclear aromatics which are discussed in separate sections in this volume are as follows: acenaphthene, fluoranthene and naphthalene. A variety of abbreviations are in common use for the polynuclear aromatics as shown below:

| Abbreviation    | Compound Designated                            |
|-----------------|--|
| A               | Anthracene                                     |
| BaA             | Benzo[a]anthracene (1,2-benzanthracene)        |
| BaP (also BP)   | Benzo[a]pyrene (3,4-benzopyrene)               |
| BbFL (also BbF) | Benzo[b]fluoranthene                           |
| BeP             | Benzo[e]pyrene                                 |
| BjFL (also BjF) | Benzo[j]fluoranthene                           |
| BkFL (also BkF) | Benzo[k]fluoranthene (11,12-benzofluoranthene) |
| BPR             | Benzo[ghi]perylene (1,12-benzoperylene)        |
| CH (also CR)    | Chrysene                                       |
| DBA             | Dibenzo[ah]anthracene (1,2,5,6-benzanthracene) |
| DBAc            | Dibenz[a,h] and [a,j] acridine                 |
| DBC             | Dibenzocarbazole                               |

(continued)



| Abbreviation   | Compound Designated    |
|----------------|------------------------|
| DBP            | Dibenzopyrene          |
| F              | Fluorene               |
| FL (also F)    | Fluoranthene           |
| IP             | Indeno[1,2,3-cd]pyrene |
| P              | Pyrene                 |
| PA (also Phen) | Phenanthrene           |
| PR (also Per)  | Perylene               |

Note: These abbreviations are not endorsed by any body such as the International Union of Chemistry; rather they are a form of shorthand used by authors for convenience, and they vary with the author.

**Code Numbers:** (For benzo[a]pyrene) CAS 50-32-8 RTECS DJ3675000

**DOT Designation:** —

**Synonyms:** PNAs, PAHs, PPAHs (Particulate Polycyclic Aromatic Hydrocarbons) and POMs (Polynuclear Organic Materials). (Benzo[a]pyrene is also known as BAP.)

**Potential Exposures:** PNAs can be formed in any hydrocarbon combustion process and may be released from oil spills. The less efficient the combustion process, the higher the PNA emission factor is likely to be. The major sources are stationary sources, such as heat and power generation, refuse burning, industrial activity, such as coke ovens, and coal refuse heaps. While PNAs can be formed naturally (lightning-ignited forest fires), impact of these sources appears to be minimal. It should be noted, however, that while transportation sources account for only about 1% of emitted PNAs on a national inventory basis, transportation-generated PNAs may approach 50% of the urban resident exposures.

Because of the large number of sources, most people are exposed to very low levels of PNAs. BAP has been detected in a variety of foods throughout the world. A possible source is mineral oils and petroleum waxes used in food containers and as release agents for food containers. FDA studies have indicated no health hazard from these sources.

The air pollution aspects of the carcinogenic polynuclear aromatic hydrocarbons (PAH) and of benzo[a]pyrene (BAP) in particular have been reviewed in some detail by Olsen and Haynes (1). The total emissions of benzo[a]pyrene (BAP) and some emission factors for BAP are as presented by Goldberg (2).

**Permissible Exposure Limits in Air:** A TLV of 0.2 mg/m<sup>3</sup> as benzene solubles has been assigned by ACGIH. These materials are designated by ACGIH as human carcinogens.

There have been few attempts to develop exposure standards for PAHs, either individually or as a class. In the occupational setting, a Federal standard has been promulgated for coke oven emissions, based primarily on the presumed effects of the carcinogenic PAH contained in the mixture as measured by the benzene soluble fraction of total particulate matter. Similarly, the American Conference of Governmental Industrial Hygienists recommends a workplace exposure limit for coal tar pitch volatiles, based on the benzene-soluble fraction containing carcinogenic PAH.

The National Institute for Occupational Safety and Health has also recommended a workplace standard for coal tar products (coal tar, creosote, and coal tar pitch), based on measurements of the cyclohexane-extractable fraction. These standards are summarized on the following page.

| Substance                    | Exposure Limit  | Agency   |
|------------------------------|---|--|
| Coke oven emissions          | 150 µg/m <sup>3</sup> , 8 hr time-weighted average                          | U.S. Occupational Safety and Health Administration         |
| Coal tar products            | 0.1 mg/m <sup>3</sup> , 10 hr time-weighted average                         | U.S. National Institute for Occupational Safety and Health |
| Coal tar pitch and volatiles | 0.2 mg/m <sup>3</sup> (benzene soluble fraction) 8 hr time-weighted average | American Conference of Governmental Industrial Hygienists  |

**Determination in Air:** Collection on a membrane filter, benzene extraction, chromatographic separation, measurement by fluorometry or using a UV detector (A-10).

**Permissible Concentration in Water:** A drinking water standard for PAH as a class has been developed. The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAH not to exceed 0.2 µg/l. This recommended standard is based on the composite analysis of six PAHs in drinking water: fluoranthene, benzo[a]pyrene, benzo[ghi]perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-cd]pyrene.

The US EPA addressed PAHs as one of the 65 priority toxic pollutants (3). They found that there was insufficient data to propose a criterion for the protection of freshwater or of saltwater aquatic life. For the protection of human health, the concentration is preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 0.028 µg/l.

**Determination in Water:** Methylene chloride extraction followed by high performance liquid chromatography (HPLC) with fluorescence or UV detection or gas chromatography (EPA Method 610), or by gas chromatography plus mass spectrometry (EPA Method 625).

**Routes of Entry:** Inhalation of particulates, vapors.

**Harmful Effects and Symptoms:** Certain PNAs which have been demonstrated as carcinogenic in test animals at relatively high exposure levels are being found in urban air at very low levels. Various environmental fate tests suggest that PNAs are photo-oxidized, and react with oxidants and oxides of sulfur. Because PNAs are adsorbed on particulate matter, chemical half-lives may vary greatly, from a matter of a few hours to several days. One researcher reports that photo-oxidized PNA fractions of air extracts also appear to be carcinogenic. Environmental behavior/fate data have not been developed for the class as a whole.

It has been observed that PNAs are highly soluble in adipose tissue and lipids. Most of the PNAs taken in by mammals are oxidized and the metabolites excreted. Effects of that portion remaining in the body at low levels have not been documented.

Benzo[a]pyrene (BaP), one of the most commonly found and hazardous of the PNAs has been the subject of a variety of toxicological tests, which have been summarized by the International Agency for Research on Cancer. 50 to 100 ppm administered in the diet for 122 to 197 days produced stomach tumors in 70% of the mice studied. 250 ppm produced tumors in the forestomach of 100% of the mice after 30 days. A single oral administration of 100 mg of nine rats produced mammary tumors in eight of them. Skin cancers have been induced in a variety of animals at very low levels, and using a variety of solvents (length of application was not specified).



Lung cancer developed in 2 of 21 rats exposed to 10 mg/m<sup>3</sup> BaP and 3.5 ppm SO<sub>2</sub> for 1 hour per day, five days a week, for more than one year. Five of 21 rats receiving 10 ppm SO<sub>2</sub> for 6 hours per day, in addition to the foregoing dosage, developed similar carcinomas. No carcinomas were noted in rats receiving only SO<sub>2</sub>. No animals were exposed only to BaP. Transplacental migration of BaP has been demonstrated in mice. Most other PNAs have not been subjected to such testing.

**Medical Surveillance:** Preplacement and regular physical examination are indicated for workers having contact with polynuclear aromatics in the workplace.

**Personal Protective Methods:** Good particulate emission controls are the indicated engineering control scheme where polynuclear aromatics are encountered in the workplace.

**Disposal Method Suggested:** Incineration.

#### References

- (1) Olsen, D.A. and Haynes, J.L., *Air Pollution Aspects of Organic Carcinogens*, Report PB-188 090, Springfield, VA, Nat. Tech. Information Service (September 1969).
- (2) Goldberg, A.J., *A Survey of Emissions and Controls for Hazardous and Other Pollutants*, Report PB-223 568, Springfield, VA, Nat. Tech. Information Service (Feb. 1973).
- (3) U.S. Environmental Protection Agency, *Polynuclear Aromatic Hydrocarbons: Ambient Water Quality Criteria*, Washington, DC (1980).
- (4) U.S. Environmental Protection Agency, *Status Assessment of Toxic Organic Chemicals: Polynuclear Aromatic Hydrocarbons*, Report EPA-600/2-79-210L, Cincinnati, OH (December 1979).
- (5) National Academy of Sciences, *Medical and Biologic Effects of Environmental Pollutants: Particulate Polycyclic Organic Matter*, Washington, DC (1972).
- (6) U.S. Environmental Protection Agency, *Health Assessment Document for Polycyclic Organic Matter*, Research Triangle Park, NC, Environmental Criteria and Assessment Office (1979).
- (7) U.S. Environmental Protection Agency, *Polynuclear Aromatic Hydrocarbons*, Health and Environmental Effects Profile No. 149, Office of Solid Waste, Washington, DC (April 30, 1980).
- (8) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France, 3, 91 (1973).
- (9) See Reference (A-62) for: Benz[a]anthracene, Benzo[b]fluoranthene and Benzo[j]-fluoranthene, Dibenz[a,h]acridine and Dibenz[j]acridine, Dibenz[a,h]anthracene, Dibenz[cd]carbazole, Dibenz[a,h]pyrene, Dibenz[a,i]pyrene, and Indeno[1,2,3-cd]pyrene.
- (10) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 35-37, New York, Van Nostrand Reinhold Co. (1984) (Acenaphthylene).
- (11) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 1755-59, Geneva, International Labour Office (1983).

### POLYTETRAFLUOROETHYLENE DECOMPOSITION PRODUCTS

**Description:** Thermal decomposition of the fluorocarbon chain in air leads to the formation of oxidized products containing carbon, fluorine and oxygen. See the entry under "Carbonyl Fluoride" to cite one example.

**DOT Designation:** —

**Synonyms:** Teflon® decomposition products.

**Potential Exposures:** Those involved in exposure of fluorocarbon plastics at high temperatures. Exposure can come from smoking cigarettes contaminated with PTFE particles. So far as is known, overheating the coatings on cooking utensils has not been a problem (A-34).

**Permissible Exposure Limits in Air:** No TLV is recommended pending determination of the toxicity of the products, but air concentrations should be minimal.

**Determination in Air:** Because these products decompose in part by hydrolysis in alkaline solution, they can be quantitatively determined in air as fluoride to provide an index of exposure.

**Permissible Concentration in Water:** No criteria set.

**Route of Entry:** Inhalation.

**Harmful Effects and Symptoms:** Workers exposed to heated PTFE fumes have developed "polymer fume fever" which is characterized by chills, fever, tightness of the chest and other influenzalike symptoms, including pulmonary edema.

### PORTLAND CEMENT

**Description:** Portland cement is a class of hydraulic cements whose two essential constituents are tricalcium silicate and dicalcium silicate with varying amounts of alumina, tricalcium aluminate, and iron oxide. The quartz content of most is below 1%. The average composition of regular Portland cement is as follows:

|                                | Percent |
|--------------------------------|---------|
| CaO                            | 64.0    |
| SiO <sub>2</sub>               | 21.0    |
| Al <sub>2</sub> O <sub>3</sub> | 5.8     |
| Fe <sub>2</sub> O <sub>3</sub> | 2.9     |
| MgO                            | 2.5     |
| Alkali oxides                  | 1.4     |
| SO <sub>3</sub>                | 1.7     |

The compounds which are contained therein are: 2CaO·SiO<sub>2</sub>, CaO·Al<sub>2</sub>O<sub>3</sub>, 3CaO·SiO<sub>2</sub> and 4CaO·Al<sub>2</sub>O<sub>3</sub>·Fe<sub>2</sub>O<sub>3</sub>.

**Code Numbers:** CAS: None RTECS VV8770000

**DOT Designation:** —

**Synonyms:** Portland cement silicate, hydraulic cement, cement.

**Potential Exposures:** Cement is used as a binding agent in mortar and concrete (a mixture of cement, gravel, and sand). Potentially hazardous exposure may occur during both the manufacture and use of cement.

**Incompatibilities:** None hazardous.

**Permissible Exposure Limits in Air:** The Federal standard for Portland cement is 50 mppcf. ACGIH classifies Portland cement as a nuisance particulate with a TLV of 30 mppcf or 10 mg/m<sup>3</sup> of total dust containing less than 1% quartz or 5 mg/m<sup>3</sup> of respirable dust.



may result in complaints of general malaise, drowsiness, loss of appetite, nausea, and unpleasant taste in the mouth, and abdominal discomfort. This may be followed by jaundice, mental confusion, stupor or delirium, hematemesis, convulsions, and purpuric rashes.

Pulmonary edema ascribed to capillary injury has been noted in severe cases, along with renal damage, though it is not known to what extent this contributes to the total toxic picture. Nephritis may develop and the urine may contain albumin and casts. Fatty degeneration of the myocardium has been reported only in animal experiments.

**Points of Attack:** Liver, kidneys, central nervous system.

**Medical Surveillance:** Preplacement and periodic examination should be comprehensive because of the possible involvement of many systems. Special attention should be given to liver, kidney, and bone marrow function, as well as to the central and peripheral nervous systems. Alcoholism may be a predisposing factor.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent any possibility of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

#### Respirator Selection:

50 ppm: CCROV/SA/SCBA

150 ppm: CCROVF/GMOV/SAF/SA:PD,PP,CF/SCBAF

Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

#### References

- (1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to 1,1,2,2-Tetrachloroethane*, NIOSH Doc. No. 77-121, Washington, DC (1977).
- (2) U.S. Environmental Protection Agency, *Chemical Hazard Information Profile: 1,1,2,2-Tetrachloroethane*, Washington, DC (1979).
- (3) U.S. Environmental Protection Agency, *Chlorinated Ethanes: Ambient Water Quality Criteria*, Washington, DC (1980).
- (4) U.S. Environmental Protection Agency, *1,1,2,2-Tetrachloroethane*, Health and Environmental Effects Profile No. 157, Washington, DC, Office of Solid Waste (April 30, 1980).
- (5) National Cancer Institute, *Bioassay of 1,1,2,2-Tetrachloroethane for Possible Carcinogenicity*, Technical Report Series No. 27, Bethesda, MD (1978).
- (6) See Reference (A-61).
- (7) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 84-85, New York, Van Nostrand Reinhold Co. (1981).
- (8) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 79-83, New York, Van Nostrand Reinhold Co. (1982).

- (9) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 2, 60-64, New York, Van Nostrand Reinhold Co. (1983).
- (10) See Reference (A-60).
- (11) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 2161-63, Geneva, International Labour Office (1983).
- (12) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. I, pp VII/318-20, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## TETRACHLOROETHYLENE

- Carcinogen (positive, NCI) (3)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:**  $\text{Cl}_2\text{C}=\text{CCl}_2$ , tetrachloroethylene, is a clear, colorless, non-flammable liquid with a characteristic odor. The odor is noticeable at 50 ppm, though after a short period it may become inconspicuous, thereby becoming an unreliable warning signal. It boils at 121°C.

**Code Numbers:** CAS 127-18-4 RTECS KX3850000 UN 1897

**DOT Designation:** ORM-A

**Synonyms:** Perchloroethylene, carbon dichloride, ethylene tetrachloride, Perclene, PCE, tetrachloroethene.

**Potential Exposures:** Tetrachloroethylene is a widely used solvent with particular use as a dry cleaning agent, a degreaser, a chemical intermediate, a fumigant, and medically as an anthelmintic.

By far the most significant exposure to PCE occurs in industrial environments. The major uses of PCE are in textile and dry cleaning industries (69%), metal cleaning (16%), and as a chemical intermediate (12%). As with inhalation exposures, dermal exposures of significance would be primarily confined to occupational exposure.

**Incompatibilities:** Strong oxidizers, chemically active metals, such as barium, lithium, beryllium. Tetrachloroethylene is quite stable. However, it reacts violently with concentrated nitric acid to give carbon dioxide as a primary product.

**Permissible Exposure Limits in Air:** The Federal standard is 100 ppm (670 mg/m<sup>3</sup>), as an 8-hour TWA with an acceptable ceiling concentration of 200 ppm; acceptable maximum peaks above the ceiling of 300 ppm are allowed for 5 minutes duration in a 3-hour period. NIOSH has recommended a time-weighted average limit of 50 ppm and a ceiling limit of 100 ppm determined by 15-minute samples, twice daily. Neither of these levels may provide adequate protection from potential carcinogenic effects because they were selected to prevent toxic effects other than cancer.

The ACGIH has set a TWA of 50 ppm (335 mg/m<sup>3</sup>) as of 1983/84 but no STEL value. An intended change, however, will involve adoption of an STEL of 200 ppm (1,340 mg/m<sup>3</sup>). The notation "skin" is added to indicate the possibility of cutaneous absorption. The IDLH level is 500 ppm. Foreign limits are lower in some cases. Thus, the German Democratic Republic has set a standard of 250 mg/m<sup>3</sup> and reportedly the USSR a standard of 1.0 mg/m<sup>3</sup>. The Dutch chemical industry has set a value of 35 ppm (240 mg/m<sup>3</sup>) (A-60).



**Determination in Air:** Adsorption on charcoal, workup with CS<sub>2</sub>, analysis by gas chromatography. See NIOSH Methods, Set J. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life—5,280 µg/l on an acute toxicity basis and 840 µg/l on a chronic toxicity basis. To protect saltwater aquatic life—10,200 µg/l on an acute toxicity basis and 450 µg/l on a chronic toxicity basis. To protect human health—preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 8.0 µg/l.

**Determination in Water:** Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

**Routes of Entry:** Inhalation of vapor, percutaneous absorption of liquid, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** *Local* — Repeated contact may cause a dry, scaly, and fissured dermatitis. High concentrations may produce eye and nose irritation.

*Systemic* — Acute exposure to tetrachloroethylene may cause central nervous system depression, hepatic injury, and anesthetic death. Cardiac arrhythmias and renal injury have been produced in animal experiments. Signs and symptoms of overexposure include malaise, dizziness, headache, increased perspiration, fatigue, staggering gait, and slowing of mental ability. These usually subside quickly upon removal into the open air.

Perchloroethylene has been found to be carcinogenic.

**Points of Attack:** Liver, kidneys, eyes, upper respiratory system, central nervous system.

**Medical Surveillance:** Evaluate skin, and liver and kidney function, as well as central nervous system. Alcoholism may be a predisposing factor.

Breath analyses may be helpful in evaluating exposures. Workers with pre-employment histories of liver, kidney, or nervous disorders should be advised as to possible increased risk.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Work clothing should be changed daily if it is possible/probable that clothing is contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Exposure to tetrachloroethylene should not be controlled with the use of respirators except: during the time period necessary to install or implement engineering or work practice controls, in work situations in which engineering and work practice controls are technically not feasible, to supplement engineering and work practice controls when such controls fail to adequately control exposure to tetrachloroethylene, for operations which require entry into tanks or closed vessels, or in emergencies.

#### Respirator Selection:

500 ppm: CCROVF/GMOV/SAF/SCBAF  
Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Alternatively, PCE may be recovered from waste gases (A-58) and reused.

#### References

- (1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Tetrachloroethylene*, NIOSH Doc. 76-185 (1976).
- (2) National Institute for Occupational Safety and Health, Current Intelligence Bulletin No. 20: *Tetrachloroethylene*, Washington, DC (January 20, 1978).
- (3) *Bioassay of Tetrachloroethylene for Possible Carcinogenicity*, DHEW Publication No. (NH) 77-813, U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Cancer Institute (October 1977).
- (4) U.S. Environmental Protection Agency, *Tetrachloroethylene: Ambient Water Quality Criteria*, Washington, DC (1980).
- (5) U.S. Environmental Protection Agency, *Health Assessment Document for Tetrachloroethylene*, External Review Draft No. 2 in circulation, Research Triangle Park, NC Environmental Criteria and Assessment Office (January 1980).
- (6) U.S. Environmental Protection Agency, *Tetrachloroethylene*, Health and Environmental Effects Profile No. 158, Washington, DC, Office of Solid Waste (April 30, 1980).
- (7) See Reference (A-61).
- (8) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. II, pp VII/364-6, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## TETRAETHYLLEAD

- Hazardous substance (EPA)
- Hazardous waste (EPA)

**Description:** Pb(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub> is a colorless liquid with a slight musty odor. It boils at 100°C. In commerce it is usually dyed red, orange or blue. Tetraethyllead will decompose in bright sunlight yielding needlelike crystals of tri-, di- and monoethyllead compounds, which have a garlic odor.

**Code Numbers:** CAS 78-00-2 RTECS TP4550000 UN 1649

**DOT Designation:** Poison B

**Synonyms:** Tetraethylplumbane (RTECS), TEL, lead tetraethyl.

**Potential Exposure:** Those engaged in the manufacture, transport and blending into gasoline of this antiknock compound.

**Incompatibilities:** Strong oxidizers, sulfuryl chloride, potassium permanganate.

**Permissible Exposure Limits in Air:** The Federal standard is 0.075 mg/m<sup>3</sup>. The ACGIH as of 1983/84 has set a TWA of 0.1 mg/m<sup>3</sup> with the notation that this is for the control of general room air and that biologic monitoring is essential for personnel control. The notation "skin" also indicates the possibility of cutaneous absorption. The STEL is 0.3 mg/m<sup>3</sup>. The IDLH level is 40 mg/m<sup>3</sup>.



**Potential Exposure:** Over 75% of DMB is used as a dye and as an intermediate in the production of dyestuffs and pigments. According to the Society of Dyers and Colorists, more than 95 dyes are derived from DMB. Approximately 20% of DMB is used in the production of polyurethane-based high-strength elastomers, coatings, and rigid plastics. DMB has also been used in small quantities in chlorine test kits by water companies and swimming pool owners and in test tapes in clinical laboratories.

Workers potentially exposed to DMB include dye makers, repackagers of DMB and dyes, workers in toluene-diisocyanate production, and clinical and analytical chemistry laboratory personnel. Workers in a variety of occupations may be exposed to small quantities of DMB used for analytical purposes, among them water and sewage plant attendants, chemical test tape or kit makers, and swimming pool service representatives. NIOSH in 1978 estimated that fewer than 100 employees were exposed to large quantities of DMB in the United States, but as many as 200,000 may be exposed to small quantities. The National Occupational Hazard Survey in 1974 estimated that 420 workers were potentially exposed to DMB.

**Permissible Exposure Limits in Air:** There are no Federal standards but ACGIH (1983/84) has designated o-tolidine as an "industrial substance suspect of carcinogenic potential for man" with no numerical TLV value.

**Permissible Concentration in Water:** No criteria set.

**Harmful Effects and Symptoms:** Skin and eye irritation.

The available test results are considered to provide sufficient evidence for the carcinogenicity of 3,3'-dimethylbenzidine in experimental animals (2). Commercial 3,3'-dimethylbenzidine (o-tolidine), when given to the rat by subcutaneous injection, caused mainly Zymbal's gland carcinomas, but mammary and forestomach tumors, and miscellaneous tumors at other sites were also present. A gastric intubation experiment with rats produced mammary carcinomas, but the result is of doubtful significance because of the small number of animals involved. In feeding experiments, the commercial product did not produce tumors in hamsters. Other experiments verified 3,3'-dimethylbenzidine as a systemic carcinogen producing multiple site tumors when given subcutaneously to the rat (1).

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, flush with water and wash contaminated areas with soap. If this chemical has been swallowed, wash with large volumes of water but do not induce vomiting (A-46).

**Personal Protective Methods:** Wear clothing and goggles to prevent skin and eye contact.

## References

- (1) International Agency for Research on Cancer, *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*, Supplement 4, Lyon, France: IARC (1982).
- (2) International Agency for Research on Cancer, *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man*, Vol 1, pp 87-91 Lyon, France: IARC (1972).

## TOLUENE

- Hazardous substance (EPA)

- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:**  $C_6H_5CH_3$ , toluene, is a clear, colorless, noncorrosive liquid with a sweet, pungent, benzenelike odor. It boils at 110° to 111°C.

**Code Numbers:** CAS 108-88-3 RTECS XS5250000 UN 1294

**DOT Designation:** Flammable liquid

**Synonyms:** Toluol, methylbenzene, phenylmethane, methylbenzol.

**Potential Exposures:** Toluene may be encountered in the manufacture of benzene. It is also used as a chemical feed for toluene diisocyanate, phenol, benzyl and benzoyl derivatives, benzoic acid, toluene sulfonates, nitrotoluenes, vinyltoluene, and saccharin; as a solvent for paints and coatings; or as a component of automobile and aviation fuels.

It is estimated that 100,000 workers are potentially exposed to toluene. At present levels of exposure to toluene in the environment, available toxicological data do not suggest that any special group in the general population would be at risk. Exposure to levels of the chemical necessary to produce physiological or toxicological effects would be anticipated primarily in occupational or solvent abuse situations. Environmental contribution of toluene in such settings should be minimal.

**Incompatibilities:** Strong oxidizers.

**Permissible Exposure Limits in Air:** The Federal standard is 200 ppm as an 8-hour TWA with an acceptable ceiling concentration of 300 ppm; acceptable maximum peaks above the ceiling of 500 ppm are allowed for 10 minutes duration. NIOSH has recommended a limit of 100 ppm (TWA) with a ceiling of 200 ppm for a 10-minute sampling period. ACGIH (1983/84) cites a TWA of 100 ppm (375 mg/m<sup>3</sup>) and an STEL of 150 ppm (560 mg/m<sup>3</sup>). The IDLH level is 2,000 ppm.

**Determination in Air:** Adsorption on charcoal, workup with CS<sub>2</sub>, analysis by gas chromatography. See NIOSH Methods, Set V. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life—17,500 µg/l on an acute toxicity basis. To protect saltwater aquatic life—6,300 µg/l on an acute toxicity basis and 5,000 µg/l on a chronic basis. To protect human health—14.3 mg/l.

**Determination in Water:** Inert gas purge followed by gas chromatography and photoionization detection (EPA Method 602) or gas chromatography plus mass spectrometry (EPA Method 624).

**Routes of Entry:** Inhalation of vapor, percutaneous absorption of liquid, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** *Local* — Toluene may cause irritation of the eyes, respiratory tract, and skin. Repeated or prolonged contact with liquid may cause removal of natural lipids from the skin, resulting in dry, fissured dermatitis. The liquid splashed in the eyes may cause irritation and reversible damage.

*Systemic* — Acute exposure to toluene predominantly results in central nervous system depression. Symptoms and signs include headache, dizziness, fatigue, muscular weakness, drowsiness, incoordination with staggering gait, skin paresthesia, collapse, and coma.

**Points of Attack:** Central nervous system, liver, kidneys, skin.



**Medical Surveillance:** Preplacement and periodic examinations should evaluate possible effect on skin, central nervous system, as well as liver and kidney function. Hematologic studies should also be done if there is significant contamination of the solvent with benzene.

Hippuric acid levels above 5 g/l of urine may result from exposure greater than 200 ppm determined as a TWA. Blood levels can also be determined for toluene.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

**Personal Protective Methods:** Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

**Respirator Selection:**

- 500 ppm: CCROV/SA/SCBA
- 1,000 ppm: CCROVF
- 2,000 ppm: GMOV/SAF/SCBAF
- Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration.

**References**

- (1) U.S. Environmental Protection Agency, *Chemical Hazard Information Profile: Toluene*, Washington, DC (1979).
- (2) U.S. Environmental Protection Agency, *Toluene: Ambient Water Quality Criteria*, Washington, DC (1980).
- (3) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Toluene*, NIOSH Doc. No. 73-11023 (1973).
- (4) U.S. Environmental Protection Agency, *Toluene*, Health and Environmental Effects Profile No. 160, Washington, DC, Office of Solid Waste (April 30, 1980).
- (5) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 83-87, New York, Van Nostrand Reinhold Co. (1982).
- (6) See Reference (A-61).
- (7) See Reference (A-60).
- (8) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 2184-86, Geneva, International Labour Office (1983).
- (9) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. II, pp VII/763, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## TOLUENE-2,4-DIAMINE

- Carcinogen (Animal Positive, IARC) (3) (4)
- Hazardous Waste (EPA)

**Description:**  $C_7H_{10}N_2$ ,  $H_3CC_6H_3(NH_2)_2$  takes the form of colorless needles melting at 99°C.

**Code Numbers:** CAS 95-80-7 RTECS XS9675000 UN (NA 1709)

**DOT Designation:** ORM-A

**Synonyms:** 3-Amino-para-toluidine, 5-amino-ortho-toluidine, 1,3-diamino-4-

methylbenzene, 2,4-diamino-1-methylbenzene, 2,4-diaminotoluene, 2,4-diaminotoluol, 4-methyl-meta-phenylenediamine, MTD.

**Potential Exposures:** Toluene-2,4-diamine is a chemical intermediate for toluene diisocyanate (used in the production of flexible and rigid polyurethane foams, polyurethane coatings, cast elastomers including fabric coatings, and polyurethane and other adhesives), and for dyes used for textiles, leather, furs, and in hair-dye formulations.

Toluene-2,4-diamine can be used for the production of about 60 dyes, 28 of which are currently believed to be of commercial significance. These dyes are generally used to color silk, wool, paper and leather. Some are also used to dye cotton, fast fibers and cellulosic fibers, in spirit varnishes and wood stains, as indicators, in the manufacture of pigments, and as biological stains.

Toluene-2,4-diamine is used as a developer for direct dyes, particularly to obtain black, dark-blue and brown shades and to obtain navy-blue and black colors on leather; it is also used in dyeing furs. It was formerly used in hair-dye formulations (to produce drab-brown, drab-blond, blue and gray shades on the hair) before this use was forbidden in 1971.

**Permissible Exposure Limits in Air:** No standards set.

**Permissible Concentration in Water:** No criteria set.

**Harmful Effects and Symptoms:** Methemoglobinemia, central nervous system depression, and degeneration of the liver typically result from exposure to toluene-2,4-diamine. Eye irritation, skin blistering, nausea, vomiting, jaundice and anemia are reported (A-38).

2,4-Diaminotoluene is carcinogenic in rats and after its oral administration, producing hepatocellular carcinomas, and its subcutaneous injection, inducing local sarcomas (3) (4).

**Points of Attack:** Central nervous system, liver.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**First Aid:** Irrigate eyes with water. Wash contaminated areas of body with soap and water.

**Personal Protective Methods:** Wear butyl rubber gloves and plastic coveralls.

**Respirator Selection:** Use self-contained breathing apparatus.

**Disposal Method Suggested:** Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

**References**

- (1) U.S. Environmental Protection Agency, *Chemical Hazard Information Profile: Toluene-2,4-Diamine*, Washington, DC (1979).
- (2) U.S. Environmental Protection Agency, *2,4-Toluenediamine*, Health and Environmental Effects Profile No. 161, Washington, DC, Office of Solid Waste (April 30, 1980).
- (3) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France 16, 83 (1978).
- (4) See Reference (A-62). Also see Reference (A-64).

## TOLUENE DIISOCYANATE

- Hazardous waste (EPA)



**Code Numbers:** CAS 76-03-9 RTECS AJ7875000 UN 1839

**DOT Designation:** Corrosive material

**Synonym:** TCA.

**Potential Exposures:** TCA is used as an intermediate in pesticide manufacture (A-32) and in the production of sodium trichloroacetate which is itself a herbicide.

**Permissible Exposure Limits in Air:** There is no Federal standard but ACGIH (1983/84) has adopted a TWA of 1 ppm (5 mg/m<sup>3</sup>). There is no STEL value. The Soviet standard is reported to be 0.75 ppm.

**Permissible Concentration in Water:** No criteria set.

**Harmful Effects and Symptoms:** TCA is corrosive to the skin and eyes but is not readily absorbed through the skin. The reader is recommended to consider the effects of 2,2-dichloropropionic acid (Dalapon) for analogies (A-34).

**Points of Attack:** Eyes, skin and respiratory tract.

**First Aid:** Get to fresh air, remove contaminated clothes, flush affected areas with water.

**Personal Protective Methods:** Wear close-fitting safety goggles, protective clothing, protective gloves.

**Respirator Selection:** Wear self-contained breathing apparatus.

#### References

- (1) See Reference (A-60).
- (2) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. 1, pp VII/18, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## 1,2,4-TRICHLOROBENZENE

- Priority toxic pollutant (EPA)

**Description:** C<sub>6</sub>H<sub>3</sub>Cl<sub>3</sub> is a low-melting solid or liquid with a pleasant aroma. It melts at 17°C and boils at 213.5°C.

**Code Numbers:** CAS 120-82-1 RTECS DC2100000 UN 2321

**DOT Designation:** Label should bear St. Andrew's Cross (X).

**Synonym:** Unsym-trichlorobenzene.

**Potential Exposures:** 1,2,4-Trichlorobenzene is used as a dye carrier (46%), herbicide intermediate (28%) (A-32), a heat transfer medium, a dielectric fluid in transformers, a degreaser, a lubricant and a potential insecticide against termites. The other trichlorobenzene isomers are not used in any quantity.

Possible human exposure to trichlorobenzene (TCB) might occur from municipal and industrial wastewater and from surface runoff (1). Municipal and industrial discharges contained from 0.1 to 500 µg/l. Surface runoff has been found to contain 0.006 to 0.007 µg/l. In the National Organic Reconnaissance Survey conducted by EPA in 1975, TCB was found in drinking water at a level of 1.0 µg/l.

**Permissible Exposure Limits in Air:** There is no Federal standard. The ACGIH has set a TWA at a ceiling of 5 ppm (40 mg/m<sup>3</sup>) but no STEL value as of 1983/84.

**Permissible Concentration in Water:** To protect human health—no criterion developed due to insufficient data.

**Determination in Water:** Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625).

**Harmful Effects and Symptoms:** *Local* — Chlorinated benzenes are irritating to the skin, conjunctiva, and mucous membranes of the upper respiratory tract. Prolonged or repeated contact with liquid chlorinated benzenes may cause skin burns.

*Systemic* — In contrast to aliphatic halogenated hydrocarbons, the toxicity of chlorinated benzenes generally decreases as the number of substituted chlorine atoms increases. Basically, acute exposure to these compounds may cause drowsiness, incoordination, and unconsciousness. Animal exposures have produced liver damage. Chronic exposure may result in liver, kidney, and lung damage as indicated by animal experiments.

**Points of Attack:** Skin, eyes, liver, kidneys, lungs.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

#### References

- (1) U.S. Environmental Protection Agency, *Chlorinated Benzenes: Ambient Water Quality Criteria*, Washington, DC (1980).
- (2) See Reference (A-60).
- (3) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 96-99, New York, Van Nostrand Reinhold Co. (1984).
- (4) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. 1, pp VII/96-7, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## 1,1,1-TRICHLOROETHANE

- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:** CH<sub>3</sub>CCl<sub>3</sub>, 1,1,1-trichloroethane, is a colorless, nonflammable liquid with an odor similar to chloroform. It boils at 74°C.

**Code Numbers:** CAS 71-55-6 RTECS KJ2975000 UN 2831

**DOT Designation:** ORM-A

**Synonym:** Methyl chloroform.

**Potential Exposures:** In recent years, 1,1,1-trichloroethane has found wide use as a substitute for carbon tetrachloride. In liquid form it is used as a degreaser and for cold cleaning, dip-cleaning, and bucket cleaning of metals. Other industrial applications of 1,1,1-trichloroethane's solvent properties include its use as a dry-cleaning agent, a vapor degreasing agent, and a propellant.

NIOSH has estimated worker exposure to 1,1,1-trichloroethane at 2,900,000 per year.



**Incompatibilities:** Strong caustics, strong oxidizers, chemically active metals, such as aluminum, magnesium powders, sodium, potassium. Upon contact with hot metal or exposure to ultraviolet radiation, it will decompose to form the irritant gases hydrochloric acid, phosgene, and dichloroacetylene.

**Permissible Exposure Limits in Air:** The Federal standard and the 1983/84 ACGIH TWA value is 350 ppm (1,900 mg/m<sup>3</sup>). NIOSH had recommended a 350-ppm ceiling as determined by a 15-minute sampling period. NIOSH has now issued criteria for a recommended standard of 200 ppm for occupational exposures to 1,1,1-trichloroethane. This recommendation to change the standards from 350 ppm is based on central nervous system responses to acute exposures in man, cardiovascular and respiratory effects in man and animals, and the absence of reported effects in man at concentrations below the proposed limit. ACGIH has set an STEL of 450 ppm (2,450 mg/m<sup>3</sup>). The Dutch Chemical Industry has set a much lower standard (A-60) of 10 ppm (45 mg/m<sup>3</sup>). The IDLH level is 1,000 ppm.

**Determination in Air:** Absorption on charcoal, workup with CS<sub>2</sub>, analysis by gas chromatography. See NIOSH Methods, Set J. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life—18,000 µg/l on an acute toxicity basis. To protect saltwater aquatic life—31,200 µg/l on an acute toxicity basis. To protect human health—1,030,000 µg/l.

**Determination in Water:** Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

**Routes of Entry:** Inhalation of vapor, moderate skin absorption, ingestion, skin and eye contact.

**Harmful Effects and Symptoms:** *Local* — Liquid and vapor are irritating to eyes on contact. This effect is usually noted first in acute exposure cases. Mild conjunctivitis may develop but recovery is usually rapid. Repeated skin contact may produce a dry, scaly, and fissured dermatitis, due to the solvent's defatting properties.

*Systemic* — 1,1,1-Trichloroethane acts as a narcotic and depresses the central nervous system. Acute exposure symptoms include dizziness, incoordination, drowsiness, increased reaction time, unconsciousness, and death. 1,1,1-Trichloroethane has been subjected to a carcinogenesis bioassay by NCI and found to be not carcinogenic (1).

**Points of Attack:** Skin, eyes, cardiovascular system, central nervous system.

**Medical Surveillance:** Consider the skin, liver function, cardiac status, especially arrhythmias, in preplacement or periodic examinations. Expired air analyses may be useful in monitoring exposure.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** 1,1,1-Trichloroethane attacks natural rubber; therefore, protective clothing of leather, polyvinyl alcohol, or neoprene is recommended. Wear appropriate clothing to prevent repeated or prolonged

skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

#### Respirator Selection:

500 ppm: CCROV/SA/SCBA  
1,000 ppm: CCROVF/GMOV/SAF/SCBAF  
Escape: GMOV/SCBA

**Disposal Method Suggested:** Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Alternative to disposal, trichloroethane may be recovered from waste gases and liquids from various processes (A-58) and recycled.

#### References

- (1) National Cancer Institute, *Bioassay of 1,1,1-Trichloroethane for Possible Carcinogenicity*, Carcinog. Tech. Rept. Ser. NCI-CG-TR-3, Washington, DC (1977).
- (2) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to 1,1,1-Trichloroethane (Methyl Chloroform)*, NIOSH Doc. No. 76-184, Washington, DC (1976).
- (3) U.S. Environmental Protection Agency, *Chlorinated Ethanes: Ambient Water Quality Criteria*, Washington, DC (1980).
- (4) U.S. Environmental Protection Agency, *1,1,1-Trichloroethane*, Health and Environmental Effects Profile No. 164, Washington, DC, Office of Solid Waste (April 30, 1980).
- (5) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 124-126, New York, Van Nostrand Reinhold Co. (1982).
- (6) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 81-85, New York, Van Nostrand Reinhold Co. (1982).
- (7) See Reference (A-61).
- (8) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 2, pp 2213-14, Geneva, International Labour Office (1983).
- (9) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. 1, pp VII/321-4, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## 1,1,2-TRICHLOROETHANE

- Carcinogen (positive, NCI) (4)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:** CH<sub>2</sub>ClCHCl<sub>2</sub>, 1,1,2-trichloroethane, is a colorless, nonflammable liquid. It boils at 113°C. It is an isomer of 1,1,1-trichloroethane but should not be confused with it toxicologically. 1,1,2-Trichloroethane is comparable to carbon tetrachloride and tetrachloroethane in toxicity.

**Code Numbers:** CAS 79-00-5 RTECS KJ3150000

**DOT Designation:** —

**Synonyms:** Vinyl trichloride, beta-trichloroethane.

**Potential Exposures:** 1,1,2-Trichloroethane is used as a chemical intermediate and as a solvent, but is not as widely used as its isomer 1,1,1-trichloroethane.

NIOSH estimates worker exposures at 112,000 per year.



# **APPENDIX B**

## **FORMS**

**Western Processing  
Initial Health and Safety Briefing\***  
Summary Form

Date \_\_\_\_\_ Time Begun \_\_\_\_\_ Time Ended \_\_\_\_\_

Briefing Location \_\_\_\_\_

Conducted By \_\_\_\_\_

| Team Members Attending (Signatures) |       |       |
|-------------------------------------|-------|-------|
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |
| _____                               | _____ | _____ |

Checklist (Check after item reviewed or completed)

|                               |       |
|-------------------------------|-------|
| General Information           | _____ |
| Safe Working Practices        | _____ |
| Hazard Information            | _____ |
| Site Description              | _____ |
| Site Layout                   | _____ |
| Personal Protective Equipment | _____ |
| Decontamination               | _____ |
| Air Quality Monitoring        | _____ |
| Medical Surveillance          | _____ |
| Emergency Response            | _____ |
| Training                      | _____ |
| Drive Route to Hospital       | _____ |

Form Completed by: \_\_\_\_\_

Date: \_\_\_\_\_

\*Must be attended by all on-site team members



**Western Processing  
Daily Health and Safety Briefing  
Summary Form**

Date \_\_\_\_\_ Time Begun \_\_\_\_\_ Time Ended \_\_\_\_\_

Briefing Location \_\_\_\_\_

Team Members Attending \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Day's Objectives (Presented by: \_\_\_\_\_ )

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Special Health and Safety Concerns (Presented by: \_\_\_\_\_ )

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Team Members' Suggestions

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Changes to Health and Safety Plan

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Other Comments

\_\_\_\_\_

\_\_\_\_\_

Form Completed by: \_\_\_\_\_

Date: \_\_\_\_\_

PERSONAL HAZARDOUS WASTE EXPOSURE RECORD

NAME: \_\_\_\_\_

SITE: \_\_\_\_\_

DATE: \_\_\_\_\_

NUMBER OF HOURS ON SITE: \_\_\_\_\_

CONDITION OF SITE: \_\_\_\_\_

AMBIENT AIR/SOIL/WATER INDICATORS:

Laboratory: G.C. \_\_\_\_\_  
P.I. Meter \_\_\_\_\_  
Other \_\_\_\_\_

On-site: G.C. \_\_\_\_\_  
P.I. Meter \_\_\_\_\_  
Other \_\_\_\_\_

TYPE OF EXPOSURE (i.e., inhalation, soil/water contact): \_\_\_\_\_

OPERATION PERFORMED (i.e., test pit inspection, sampling, drilling): \_\_\_\_\_

CHEMICALS BURIED OR KNOWN PRESENT: \_\_\_\_\_

PROTECTIVE EQUIPMENT WORN:

\_\_\_ Safety Shoes (Steel Toe & Shank)  
\_\_\_ Chemical Resistant Boots,  
    Type: \_\_\_\_\_  
\_\_\_ Half-Face Respirator  
    Type of Cartridge: \_\_\_\_\_  
\_\_\_ Full-Face ResiratorR  
    Type of Cartridge: \_\_\_\_\_

\_\_\_ Inner Lab Gloves  
\_\_\_ Outer Chemical Resistant GLOVES  
    Type: \_\_\_\_\_  
\_\_\_ Coveralls  
    Type: \_\_\_\_\_  
\_\_\_ \_\_\_\_\_  
\_\_\_ \_\_\_\_\_

DECONTAMINATION MEASURES TAKEN:

\_\_\_ Change of Clothes  
\_\_\_ Shower  
\_\_\_ Change of Protective Equipment

\_\_\_ \_\_\_\_\_  
\_\_\_ \_\_\_\_\_  
\_\_\_ \_\_\_\_\_

PERSONAL PROTECTIVE DECONTAMINATION PROCEDURES: \_\_\_\_\_

UNUSUAL SITE CONDITIONS/OCCURRENCES: \_\_\_\_\_

OBSERVED HEALTH EFFECTS: \_\_\_\_\_

NOTES: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



EMPLOYEE EXPOSURE/INJURY INCIDENT REPORT

(SUBMIT A SEPARATE REPORT FOR EACH INCIDENT  
TO THE CORPORATE HEALTH AND SAFETY DIRECTOR)

Date: \_\_\_\_\_

Employee's Name: \_\_\_\_\_

Sex: M \_\_\_\_ F \_\_\_\_ Age: \_\_\_\_

Region: \_\_\_\_\_ Location: \_\_\_\_\_

Project: \_\_\_\_\_

Project Job Title: \_\_\_\_\_

Incident:

Type: Possible Exposure \_\_\_\_ Exposure \_\_\_\_ Physical Injury \_\_\_\_ Other \_\_\_\_

Location: \_\_\_\_\_

Date of Incident: \_\_\_\_\_ Time of Incident: \_\_\_\_\_

Date of Reporting Incident: \_\_\_\_\_

Person to Whom Incident Was Reported: \_\_\_\_\_

Weather Condition During Incident: Temperature \_\_\_\_\_

Wind speed & direction \_\_\_\_\_ Humidity \_\_\_\_\_

Cloud Cover \_\_\_\_\_ Clear \_\_\_\_\_ Precipitation \_\_\_\_\_

Materials Potentially Encountered:

Chemical (Give chemical name or description--liquid, solid, gas, vapor, fume, mist):

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Radiological: \_\_\_\_\_

Others: \_\_\_\_\_

Nature of the Exposure/Injury:

State the nature of the exposure/injury in detail and list the parts of the body affected. (Attach extra sheets if needed.)

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Did you receive medical care? Yes \_\_\_\_\_ No \_\_\_\_\_

If so, when? \_\_\_\_\_

Where? On-Site \_\_\_\_\_ Off-Site \_\_\_\_\_

By Whom? Name of Paramedic: \_\_\_\_\_

Name of Physician: \_\_\_\_\_

Other: \_\_\_\_\_

If "Off-Site", name facility (hospital, clinic, etc.):

Length of stay at the facility? \_\_\_\_\_

Was the Health and Safety Director contacted: Yes \_\_\_\_\_ No \_\_\_\_\_ When? \_\_\_\_\_

Was the Medical Consultant contacted? Yes \_\_\_\_\_ No \_\_\_\_\_

If so, who was the contact? \_\_\_\_\_

Did the exposure/injury result in permanent disability? Yes \_\_\_\_\_ No \_\_\_\_\_

If so, explain: \_\_\_\_\_

---

---

Has the employee returned to work? Yes \_\_\_\_\_ No \_\_\_\_\_

If so, give date: \_\_\_\_\_



List the names of other persons affected during this incident:

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---

---

List the names of persons who witnessed the exposure/injury incident:

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---

---

Possible cause of the exposure/injury:

What was the name and title of the field team leader or immediate supervisor at the site of the accident?

---

Was the operation being conducted under an established Safety Plan?

Yes \_\_\_\_ No \_\_\_\_ If Yes, attach a copy. If no, explain.

---

Describe protective equipment and clothing used by the employee:

---

---

---

Other information, comments (Attach relative data if necessary):

---

---

---

Did any limitations in safety equipment or protective clothing contribute or affect exposure? If so, explain:

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---

What was the employee doing when the exposure/injury occurred? (Describe briefly as "Site Reconnaissance", "Site Categorization", "Sampling", etc.)

---

---

---

Where exactly on-site or off-site did the exposure/injury occur?

---

---

---

How did the exposure/injury occur? (Describe fully what factors led up to and/or contributed to the incident.)

---

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---

Name of person(s) initiating report, job title, phone number:

---

---

\_\_\_\_\_  
Employee Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Site Safety Director

\_\_\_\_\_  
Date



## **APPENDIX C**

### **PERSONAL PROTECTIVE EQUIPMENT INSTRUCTIONS**

## Appendix C: Personal Protective Equipment Instructions

- I. Respirator Instructions
  - A. Respirator Checkout
  - B. Donning Respirator
  - C. Storing Respirator
- II. SCBA Instructions
  - A. SCBA Checkout
  - B. Donning SCBA
  - C. Doffing SCBA
  - D. Storing SCBA
  - E. SCBA Monthly Inspection
- III. Donning Scott Scat-Pak



## I. RESPIRATOR INSTRUCTIONS

### A. Respirator Checkout

1. Inspect head harness and facepiece for damage, serrations, and deteriorated rubber.
2. Inspect lens for damage and proper seal in facepiece.
3. Inspect exhalation valve for damage and dirt build-up.
4. Stretch breathing tube and carefully inspect for holes and deterioration.
5. Inspect connector for damage and presence of washer.

### B. Donning Respirator

1. Conduct respirator checkout.
2. Place respirator over face, and pull head harness back over head.
3. Secure the bottom straps and then the top straps on the respirator, carefully pushing hair away from the seal area.
4. The mask should not be so tight as to cause discomfort or headache.
5. Conduct a positive pressure test by covering exhalation valve with hand and blowing air out.
6. Conduct a negative pressure test by covering inhalation port with hand and sucking air in.

### C. Storing Respirator

1. Decontaminate and sanitize respirator.
2. Store respirator in a clean plastic bag for protection.

## II. SCBA INSTRUCTIONS

### A. SCBA Checkout

#### 1. Initial Checks

- High-pressure-hose connector is tight on cylinder fitting.
- By-pass valve is closed.
- Mainline valve is closed.
- Regulator outlet is not covered or obstructed.

#### 2. Backpack and Harness Assembly

- Visually inspect straps for wear, damage, completeness.
- Check wear and function of buckle.
- Check backplate for damage and attachment to cylinder.

#### 3. Cylinder and High-Pressure-Hose Assembly

- Check cylinder to assure that it is firmly fastened to backplate.
- Open cylinder valve; listen or feel for leakage around packing and hose connection.
- Check high-pressure-hose for damage or leaks.

#### 4. Regulator

- Cover regulator outlet with palm of hand.
- Open mainline valve.
- Note stoppage of air flow after positive pressure builds.
- Close mainline valve.
- Remove hand from regulator outlet.
- Open by-pass valve slowly to assure proper function.
- Close by-pass valve.
- Cover regulator outlet again with palm of hand.
- Open mainline valve.
- Note pressure reading on regulator gauge.
- Close cylinder valve while keeping hand over regulator outlet.
- Slowly remove hand from outlet and allow air to flow.
- Note pressure when low-pressure warning alarm sounds; it should be between 550-650 psi.
- Remove hand from regulator outlet.
- Close mainline valve.
- Check regulator for leaks; blow air into regulator for 5-10 seconds; suck air from outlet for 5-10 seconds. If a positive pressure or vacuum cannot be maintained, do not use the SCBA unit because it is leaking.

### B. Donning SCBA

1. Conduct SCBA checkout.
2. Place SCBA air cylinder on back with assistance of buddy or



- site safety officer.
3. Secure shoulder and waist straps on harness assembly.
4. Don respirator (see respirator instructions).
5. Open cylinder valve by turning valve as far as possible.
6. Open mainline valve.
7. Connect breathing hose to respirator.

C. Doffing SCBA

1. Remove respirator from face.
2. Close SCBA mainline valve and cylinder valve.
3. Disconnect breathing hose from respirator.
4. Remove SCBA unit from back with assistance of buddy or site safety officer.

D. Storing SCBA

1. Decontaminate backpack and harness assembly.
2. Slowly empty air cylinder if unit will be transported.
3. Carefully pack unit in carrying/storage case.

E. SCBA Monthly Inspection

1. Check cylinder label for current hydrostatic test date.
2. Inspect cylinder for large dents or gouges in metal.
3. Check presence of cylinder lock.
4. Inspect cylinder gauge for damage.
5. Complete full checkout procedure.
6. Fill out appropriate records.

### III. DONNING SCOTT SCAT-PAK

1. Lift flap and remove hood from pouch.
2. Turn valve on by turning knob counterclockwise.
3. Remove and discard other respirator (if one is being worn).
4. Slip hood over head, making sure that hose outlet is in front of face.
5. Pull drawstring tight and adjust elastic neck band.